\*\*\*FYI about Transorbital Railroad\*\*\*

FYI—How the TR works

Zubrin, ’10 [Robert Zubrin is a New Atlantis contributing editor, a fellow at the Center for Security Policy, and the president of Pioneer Astronautics, an aerospace engineering R&D firm. He also leads the Mars Society, an international organization dedicated to furthering space exploration, “Opening Space with a ‘Transorbital Railroad’,” The New Atlantis, Fall 2010, http://www.thenewatlantis.com/publications/opening-space-with-a-transorbital-railroad]

In the history of the American frontier, the opening of the transcontinental railroad was an epochal event. Almost instantly, the trip to the West Coast, which had previously required an arduous multi-month trek and a massive investment for an average family, became a quick and affordable excursion. With the easing of commerce and communication across the continent, economic growth rapidly accelerated, creating new industries, new prosperity, and new communities. Can we today deliver a similar masterstroke, and open the way to the full and rapid development of the space frontier? Can we open a “transorbital railroad”? Here’s how it could be done. First, we could set up a small transorbital railroad office in NASA, and fund it to buy six heavy-lift launches (100 tonnes to low-Earth orbit) and six medium-lift launches (20 tonnes to low-Earth orbit) per year from the private launch industry, with heavy- and medium-lift launches occurring on alternating months. (A tonne is a metric ton — 1,000 kilograms, or about 2,200 pounds.) The transorbital railroad office would pay the launch companies $500 million for each heavy launch and $100 million for each medium launch, thus requiring a total program expenditure of $3.6 billion per year — roughly 70 percent of the cost of the space shuttle program. NASA would then sell standardized compartments on these launches to both government and private customers at subsidized rates based on the weight of the cargo being shipped. For example, on the heavy-lift vehicle, the entire 100-tonne-capacity launch could be offered for sale at $10 million, or divided into 10-tonne compartments for $1 million, 1-tonne subcompartments for $100,000, and 100-kilogram slots for $10,000 each. The same kind of pricing could be offered on the medium-lift launcher. While recovering only a tiny fraction of the transorbital railroad’s costs, such low fees (levied primarily to discourage spurious use) would make spaceflight readily affordable. As with a normal railroad here on Earth, the transorbital railroad’s launches would occur in accordance with its schedule, regardless of whether or not all of its cargo capacity was subscribed by customers. Unsubscribed space would be filled with containers of water, food, or space-storable propellants. These standardized, pressurizable containers, equipped with tracking beacons, plumbing attachments, hatches, and electrical pass-throughs, would be released for orbital recovery by anyone with the initiative to collect them and put their contents and volumes to use in space. A payload dispenser, provided and loaded by the launch companies as part of their service, would be used to release each payload to go its separate way once orbit was achieved.

\*\*\*\*Transorbital Railroad Solvency\*\*\*\*

The transorbital railroad ensures the fast development of cheap launch technology and leads to SSP, space tourism and lunar/Mars probes

Zubrin, ’10 – Fellow at Center for Policy Studies and President of Mars Society and Pioneer Astronautics

[Robert Zubrin, “Opening Space with a ‘Transorbital Railroad’,” The New Atlantis, Fall 2010, http://www.thenewatlantis.com/publications/opening-space-with-a-transorbital-railroad]

As noted above, the budget required to run the transorbital railroad would be 30 percent less than the space shuttle program, but it would accomplish far more. Since its inception in the early 1980s, the space shuttle program has averaged about four launches per year. Given the shuttle’s theoretical maximum payload capacity (rarely used in full) of about 25 tonnes, this means that the shuttle program could be expected to deliver no more than 100 tonnes to low-Earth orbit per year. By contrast, the transorbital railroad would launch 720 tonnes per year. The U.S. government would thus save a great deal of money, since its own departments in NASA, the military, and other agencies could avail themselves of the transorbital railroad’s low rates to launch their payloads at trivial cost. Much further savings would occur, however, since with launch costs so reduced, it would no longer be necessary to spend billions to ensure the ultimate degree of spacecraft reliability. Instead, commercial-grade parts could be used, thereby cutting the cost of spacecraft construction by orders of magnitude. While some failures would result, they would be eminently affordable, and moreover, enable a greatly accelerated rate of technological advance in spacecraft design, since unproven, non-space-rated components could be much more rapidly put to the test. With both launch and spacecraft costs so sharply reduced, the financial consequences of any failures could be readily met by the purchase of insurance by the launch companies, which would reimburse both the government and payload owners in the event of a mishap. With such a huge amount of lift capability available to the public at low cost, both public and private initiatives of every kind could take flight. If NASA desired to send human expeditions to other worlds, all it would have to do would be to buy space on the transorbital railroad for its payloads. But private enterprises or foundations could use the transorbital railroad to launch their own lunar or Mars probes — or settlements — as well. Those who believe in solar-power satellites would have the opportunity to put their business plans into action. Those wishing to operate orbital space hotels would have the launch capacity necessary to make their concepts feasible. Those hoping to offer commercial orbital ferry service to transfer payloads from low-Earth orbit to geostationary orbit or beyond would be able to get their crafts aloft, and have plenty of customers. As such enterprises multiplied, a tax base would be created both on Earth and in space that would ultimately repay the government many times over for its transorbital railroad program costs.

Solvency advocate—NASA scientists and researchers support the plan

Clark, ‘11

[Stephen Clark, Rising launch costs could curtail NASA science missions,” Space Flight Now, 4/4/11, http://spaceflightnow.com/news/n1104/04launchcosts/]

Scientists say it's time for NASA to get creative to solve the launch cost dilemma. NASA should return to buying launch vehicles in bulk instead of one at a time, according to the planetary science decadal survey. Such a move would signal a return to the former NASA practice of block buys of the Delta 2 rocket. "If you buy several rockets at once, maybe you can get a deal," Squyres said. Although technical and programmatic issues could stand in the way, researchers recommended launching more satellites in groups, sharing rocket costs among two or more projects.

AT: Launch Costs Reducing/Space Commercializing

Launch costs remain too high

Kutter, ‘8

[Bernard F. Kutter, Lockheed Martin Space Systems Company, Commercial Launch Services: an Enabler for Launch Vehicle Evolution and Cost Reduction, AIAA-2006-7271, 2008]

Expanded space exploration and utilization has been stymied partially by the high cost of space access. Since the Apollo era, numerous efforts have been under taken to significantly reduce the cost of space access in the hope that development of a low cost launch system will stimulate demand, enabling new uses of space for the betterment of mankind. These efforts at reducing the cost of space access through launch vehicle development have had mixed results. Although the EELV DoD-industry partnership made significant improvement in America’s space access, continued enhancement is ham strung by the very low launch requirement of the existing space market. For decades the promise of commercial space business has promised to hugely increase this demand, resulting in continued, significant space transportation cost reduction. Continuously this commercial promise has proven to be a mirage.

Commercialization Impossible without lower costs—Need gov’t and private coop

Reynolds, ‘8

[Jackie Dewayne Reynolds, Space Advocacy Revisited: A Renewed Call to Arms, 10/08, http://www.jackiedewaynereynolds.info/jackie-dewayne-reynolds-writings-space-advocacy-revisited]

However, the large-scale development and commercialization of space we space advocates long for will remain an illusive dream so long as launch costs remain prohibitively high (Elhefnawy). How could a multi-billion dollar industry with both government and popular support fail to deliver on such a fundamental promise as routine access to space? Very simply, it’s a failure of cooperation. These three divisions (private industry, government, and public advocacy groups) fail to share information and resources.

AT: Alt Causes to Launch Costs

High upfront costs is the largest reason for high launch costs—plan solves

Plan solves the alt causes—Reduced launch costs open new space markets—ensuring long-term cost reduction

Coopersmith, ‘11

[Jonathan Coopersmith, Texas A&M University, The cost of reaching orbit: Ground-based launch systems, Space Policy 27:2, May 2011, Science Direct]

Radically reduced cost creates radically new markets. The capability to launch thousands of tons inexpensively every year provides opportunities for applications previously considered impossible. Two potential markets with annual demand in the thousands of tons could prove the “killer app” that justifies devel- oping GBS: space-based solar power generation and nuclear waste disposal in solar orbit.

Government subsidization ensures large-scale and cheap space exploration

Coopersmith, ‘11

[Jonathan Coopersmith, Texas A&M University, The cost of reaching orbit: Ground-based launch systems, Space Policy 27:2, May 2011, Science Direct]

Reducing the cost to reach orbit will have, as the 2007 NSSO report proclaimed, “a transformational, even revolutionary effect on space access.”29 Yet a good idea is only the first of many necessary steps for a successful technology. To develop GBS’ potential and distinguish its fate from the many promising technologies that are never developed will demand a dedicated effort. Just as government funding developed the technology to extend our first tentative footsteps into space, so too can a dedicated government program provide the technology to truly enable the large-scale exploration and exploitation of space. As Walter Faulconer, the former chief scientist of the Applied Physics Laboratory, stated in 2010, reducing the cost of access to space “is to me one of the biggest game-changers out there.”30 By vastly extending the range of the possible, low-cost launches will make the second half-century of the Space Age even more exciting than the first half-century.

Plan leads to market competition driving down launch costs

Crowther, ‘11

[Richard Crowther, UK Space Agency, Polaris House, “The regulatory challenges of ensuring commercial human spaceflight safety,” Space Policy 27 (2011) 74-76.]

Space tourism is creating a new market niche. Like the aircraft industry in the 20th century, money from these early ventures is expected in turn to fund new technologies and vehicles to meet the needs of the growing industry. As the space tourism industry grows, it is argued that transportation into space will become more efficient, and more affordable, to more customers. Space tourism has the potential to act as an economic “driver” for more frequent flights into space, leading to market competition to drive down launch costs, which in turn will attract other more customers to the space market. The anticipated demand for space tourism launch services requires aerospace companies to develop reusable, highly reliable spacecraft. The general argument is that this private sector space technology research for commercial flight operations will improve spaceflight capabilities, develop spin-off technologies which can benefit government programmes, and help to position the UK in the developing global knowledge economy. Reusable, reliable launch vehicles can also reduce the current costs of space- based systems. These systems are recognized as part of the UK’s critical national infrastructure, upon which we rely for communi- cations, meteorology, environmental monitoring, search and rescue operations, and security; hence the opportunity to develop a cost- effective and responsive means of delivering these systems to orbit is be encouraged.

AT: Plan Doesn’t Decrease Launch Costs

Plan decreases launch costs

Zubrin, ’11 –Aerospace Enginer

Robert Zubrin, an aerospace engineer, is President of the Mars Society, The Mars Quarterly, 3(1), Summer 2011

We don’t even have to wait for the Falcon Heavy to implement the transorbital railroad. We can begin it straight away, with 12 existing medium-lift launches per year. Once the Falcon Heavy becomes available, it could be integrated into the program to enable the full transorbital railroad capability discussed above. With a large guaranteed market, launch vehicle companies would compete hard to create ever more capable systems. They also would be able to put mass-production techniques into action, thereby causing the costs of their rockets to fall over time. This, in turn, would allow the transorbital railroad to further increase the frequency and capacity of its service, and would result in a dramatic drop in the cost of launch vehicles bought outside of the transorbital railroad program as well.

Empirically gov’t support of the private sector reduces launch costs

Dillingham, ’11- Dir. Of Physical Infrastructures Issues

[Gerald L. Dillingham, Ph. D., Director of Physical Infrastructure Issues, “COMMERCIAL SPACE TRANSPORTATION Industry Trends and Key Issues Affecting Federal Oversight and International Competitiveness”, 5/5/2011, http://www.gao.gov/new.items/d11629t.pdf]

We reported in 2006 that as the commercial space launch industry expands, it will face key competitive issues concerning high launch costs and export controls that affect its ability to sell its services abroad. Foreign competitors have historically offered lower launch prices than U.S. launch providers, and the U.S. industry has responded by merging launch companies, forming international partnerships, and developing lower-cost launch vehicles. For example, Boeing and Lockheed Martin merged their launch operations to form United Launch Alliance, and SpaceX developed a lower-cost launch vehicle. The U.S. government has responded to the foreign competition by providing the commercial launch industry support, including research and development funds, government launch contracts, use of its launch facilities, and third-party liability insurance through which it indemnifies launch operators. The continuation of such federal involvement will assist industry growth, according to industry experts that we spoke with. For example, the U.S. government indemnifies launch operators by providing catastrophic loss protection covering launch operators by providing catastrophic loss protection covering third-party liability insurance for up to $500 million in addition to insurance for their vehicle and its operations, and the U.S. government provides up to $1.5 billion in indemnification. Some industry experts have said that government indemnification is important because the cost of providing insurance for launches could be unaffordable without indemnification. A senior Department of Commerce official told us that without federal indemnification, smaller launch companies may go out of business.

Govt purchase of private sector launch vehicles spurs commercial development making the US competitive

Kutter, ‘8

[Bernard F. Kutter, Lockheed Martin Space Systems Company, Commercial Launch Services: an Enabler for Launch Vehicle Evolution and Cost Reduction, AIAA-2006-7271, 2008]

The retirement of the space shuttle and the transition to the VSE provides a unique opportunity for America to encourage competitive, commercial launch resulting in a stronger, healthier, more robust launch industry, with reduced launch costs for all. America’s current competitive (medium to large payload) launch market is comprised of the launch of DoD, NASA science and commercial satellites launching approximately 346 klb (157 mT) on 15 launches per year, Figure 7. The DoD launch requirements dominate and control this launch market. Without the strong emergence of commercial tourism or similar new launch markets it is expected that this current competitive launch market will remain relatively static for the foreseeable future. NASA/NOAA NASA’s future launch requirements consist of ISS servicing and exploration. These requirements offer the opportunity to increase America’s launch demand by a factor of four. This increases the annual launch requirements from today’s 346 klb (157 mT) to 1,546 klb EELV HLV, 30 (700 mT), Figure 8. NASA will control the bulk of this future launch market. As such, NASA has the ability to control America’s future launch environment. NASA has the opportunity to commercially purchase all of its future launch needs. Such a huge increase in the American launch market may well stimulate a new era of competition and advancement resulting in significantly lower launch costs and enhance space access for all; NASA, DoD and commercial users.

AT: Tech Not Ready Now

It’s ready now—equipment is available and the existing competitive market will reduce costs

Zubrin, ’10 – Fellow at Center for Policy Studies and President of Mars Society and Pioneer Astronautics

[Robert Zubrin, “Opening Space with a ‘Transorbital Railroad’,” The New Atlantis, Fall 2010, http://www.thenewatlantis.com/publications/opening-space-with-a-transorbital-railroad]

We don’t have to wait years to implement the transorbital railroad. We already have the capability to begin it right away, with twelve medium-lift launches per year using existing Atlas V, Delta IV, and Falcon 9 rockets. This would cost only $1.2 billion yearly, so if the program were fully budgeted from the beginning, more than $2 billion per year would still remain to support the development of heavy-lift vehicles through two or more fixed-price contracts issued on a competitive basis. Once these heavy-lift launchers became available, the full transorbital railroad service would be enabled. With a guaranteed market, launch vehicle companies would be able to put mass-production techniques into action, thereby causing the costs of their rockets to fall over time. This, in turn, would allow the transorbital railroad to further increase the frequency of its service, from one launch per month to two, three, or more, and would result in a dramatic drop in the cost of launch vehicles bought outside of the transorbital railroad program as well.

Market competition is guaranteed

Zubrin, ‘ 11 -- Fellow at Center for Policy Studies and President of Mars Society and Pioneer Astronautics

[Robert Zubrin, “Treating Space like the American West,” Washington Times, Reprinted in The Mars Society, 05.25.11, http://www.marssociety.org/home/press/tms-in-the-news/treatingspaceliketheamericanwest]

With a large guaranteed market, launch-vehicle companies would compete hard to create ever-more-capable systems. They also would be able to put mass-production techniques into action, thereby causing the costs of their rockets to fall over time. This, in turn, would enable the transorbital railroad to increase further the frequency and capacity of its service and would result in a dramatic drop in the cost of launch vehicles bought outside of the transorbital railroad program as well.

We can spend people to space now (Prosey card)

Zubrin, ’10 – Fellow at Center for Policy Studies and President of Mars Society and Pioneer Astronautics

[Robert Zubrin, “Opening Space with a ‘Transorbital Railroad’,” The New Atlantis, Fall 2010, http://www.thenewatlantis.com/publications/opening-space-with-a-transorbital-railroad]

Within a few years, we could be sending not a mere handful of people per year to orbit, but hundreds. Instead of a narrow space program with timid objectives moving forward at the snail’s pace of politically constrained bureaucracy, we could have dozens of bold endeavors of every kind, attempting to realize every vision and every dream — reaching out, taking risks, and proving the impossible to be possible. With the aid of the transorbital railroad, the vast realm of the solar system could be truly opened to human hands, human minds, human hearts, and human enterprise: a great new frontier for free men and women to explore and settle, their creativity unbounded, with prospects and possibilities as unlimited as space itself.

Heavy-lift tech will be on the market by 2013

Matson, ‘11

[John Matson, Lofting Aspirations, Scientific American, 4/6/11, http://www.scientificamerican.com/article.cfm?id=falcon-heavy-rocket]

Come 2013, the burliest rocket in the world may belong not to NASA, Boeing or any of the other traditional heavy-hitters in the aerospace field. It will belong to a relative newcomer, if start-up spaceflight firm SpaceX has its way. PayPal co-founder Elon Musk, who heads up the Hawthorne, Calif., company, announced at an April 5 news conference that SpaceX is building a new rocket, called Falcon Heavy, with enough thrust to lift 53,000 kilograms into low Earth orbit. The heavy-lift rockets currently in use around the world, such as NASA's soon-to-be-retired space shuttle; the Delta 4, operated by Boeing and Lockheed Martin's United Launch Alliance; and the European Space Agency's Ariane 5 top out at a payload capacity of around 20,000 to 25,000 kilograms. (NASA's Saturn 5 booster of the Apollo era, with an orbital payload capacity of 118,000 kilograms, was far more powerful than anything in existence today.) The announcement arrives at a troubled time for NASA's own efforts to build a new heavy-lift rocket for travel into deep space. Budgetary woes and a set of goals that do not always dovetail with those of Congress have made NASA's proposed heavy-lift Space Launch System a controversial subject. (In short, Congress has mandated a set of specs for the system, which NASA's chief has said are neither feasible nor necessary.) SpaceX says the Falcon Heavy rocket is designed to meet NASA's safety standards for human spaceflight, but it might take more than one launcher to send a manned mission to a near-Earth asteroid or some other deep-space destination.

Heavy launch tech is possible—the knowledge already exists

Zubrin, ‘ 10 -- Fellow at Center for Policy Studies and President of Mars Society and Pioneer Astronautics

[Robert Zubrin, “Wrecking NASA” Commentary, Jun2010, Vol. 129, Issue 6]

Finally, it is simply not the case that we need new technologies to create heavy-lift launch systems. We not only know how to build them; we actually flew our first heavy-lifter, the Saturn, in 1967, just five years after the Apollo-program contract to create it was signed. In the period since, however, instead of missions requiring booster-production contracts, NASA funded a series of launcher-technology research programs.\* None of these resulted in the development of any real-flight hardware. Under the Constellation program, NASA developed a fully satisfactory design for a Saturn 5 equivalent booster, which it called the Ares 5. Yet, instead of proceeding with its development, Holdren has canceled it, promising to produce a new design, after further research, by 2015. But all that is needed to give us a functioning heavy-lift booster is a decision to build it, which will never happen until there is a suitable mission.

Even if not yet practical, we should try

Wagstaff, ’11 –Coeditor of Utopianist. Writes about tech

[Keith Wagstaff, “The Transorbital Railroad Could Fly Passengers and Cargo into Space” The Utopianist, http://utopianist.com/2011/02/individuals-could-ride-to-space-through-the-transorbital-railroad/]

I agree. If I have the resources to research and build the Utopianist Intergalactic Party Bus, then I don’t know why I shouldn’t be able to assume the risk that comes with launching it into orbit. In days of yore, sailors set across the Atlantic half-expecting to fall off the edge of the world or get eaten by sea monsters. The result was discovering an entirely new (well, to Europeans anyway) continent. If we as a civilization want similar results, we need to allow our more adventurous citizens and companies to take risks according to their own judgement. This plan isn’t exactly pie-in-the-sky either; we can already launch medium-sized lifts into space. Successfully launching a 100-tonne capacity heavy lift is most likely just a matter of time. Hopefully instituting the transorbital railroad is too.

AT: Private Sector Not Doing Heavy Lift

The private sector is showing interest

Matson, ‘11

[John Matson, Lofting Aspirations, Scientific American, 4/6/11, http://www.scientificamerican.com/article.cfm?id=falcon-heavy-rocket]

The Falcon Heavy's first rocket stage will comprise three sets of nine Merlin engines, essentially tripling the booster array that SpaceX uses on its smaller Falcon 9 rocket. A finished Falcon Heavy should reach California's Vandenberg Air Force Base in late 2012 for a test flight in 2013, Musk announced during a news conference at the National Press Club in Washington, D.C. He said that both the U.S. government and the private sector had expressed "strong interest" in using the Falcon Heavy to launch spacecraft and satellites into orbit. (The appeal of larger rockets is their capacity to launch heavier spacecraft or multiple spacecraft at one time.)

AT: Can’t use the Falcon

Progress is being made on certification

Atlas, ’11 [Atlas Aerospace, Industry news, Rising launch costs may hinder NASA missions, 4/06/11, http://www.atlasaerospace.net/eng/newsi-r.htm?id=5411&printversion=1]

The NASA Launch Services contract includes the Atlas 5 rocket from ULA, Falcon launchers from SpaceX, the Orbital Sciences Corp. Pegasus XL and Taurus XL boosters, and the Athena rocket family from Lockheed Martin. Cline said the Falcon 9 rocket, while not as capable as the Atlas 5, is considerably less costly. But the Falcon 9 rocket, privately designed and tested by SpaceX, does not yet meet NASA's stringent certification standards for its most precious science missions. "We are anxious to do that as soon as we can," Cline said.

Falcon not necessary

Zubrin, ’11 –Aerospace Enginer

Robert Zubrin, an aerospace engineer, is President of the Mars Society, The Mars Quarterly, 3(1), Summer 2011

We don’t even have to wait for the Falcon Heavy to implement the transorbital railroad. We can begin it straight away, with 12 existing medium-lift launches per year. Once the Falcon Heavy becomes available, it could be integrated into the program to enable the full transorbital railroad capability discussed above. With a large guaranteed market, launch vehicle companies would compete hard to create ever more capable systems. They also would be able to put mass-production techniques into action, thereby causing the costs of their rockets to fall over time. This, in turn, would allow the transorbital railroad to further increase the frequency and capacity of its service, and would result in a dramatic drop in the cost of launch vehicles bought outside of the transorbital railroad program as well.

\*\*\*\*Solar Power Satellites Adv.\*\*\*\*

1AC Solar Power Satellites Adv.

All major energy sources are finite – exhaustion is inevitable – only SSP can meet rising global demand

Snead 8 – MS in Aerospace Engineering

[Mike Snead, MS in Aerospace Engineering from Air Force Institute of Technology, Past Chair of American Institute of Aeronautics and Astronautics, Former director of Science & Technology, HQ Air Force Materiel Command, Awarded Outstanding Achievement for Excellence in Research @ USAF, 11-19-2008, “The End of Easy Energy and What to Do About It,” http://mikesnead.net/resources/spacefaring/white\_paper\_the\_end\_of\_easy\_energy\_and\_what\_to\_do\_about\_it.pdf]

By 2100, the number of people actually using electricity and modern fuels will more than double. Of the world’s current 6 .6 billion people, 2.4 billion do not have access to modern fuels and 1.6 billion do not have access to electricity. As a result, a substantial percentage of the world’s population lives in a state of energy deprivation that substantially impacts health, individual economic opportunity, social and political stability, and world security. By 2100, the world’s population is projected to climb another 3.4 billion to roughly 10 billion. This means that by 2100, an additional 5-6 billion people, not using modern fuels and electricity today, must be provided with assured, affordable, and sufficient energy supplies if the world’s current energy insecurity is to be substantially eliminated. 2. By 2100, to meet reasonable energy needs, the total world’s energy production of electricity and modern fuels must increase by a factor of about 3.4X while that of the United States must increase by a factor of 1.6X. The annual per capita total energy consumption of Japan, South Korea, and Europe averages about 30 barrels of oil equivalent or BOE. Further energy conservation may reduce this to about 27 BOE per year. This value is used in this paper as a level of energy consumption needed for a modern standard of living and a stable political and economic environment outside the United States. By 2100, should the non-U.S. world population achieve this modern “middle class” standard of living, the world will require an annual energy supply of around 280 billion BOE. In 2006, the world’s electricity and modern fuels energy supply was about 81 billion BOE. Hence, by 2100, the world will need on the order of 3 .4X more energy than was being produced in 2006. In the United States, a near doubling of the population by 2100, even with a 20% reduction in per capita energy use, will require a 1.6X increase in U.S. energy needs. 3. If oil, coal, and natural gas remain the predominant source of energy, both known and expected newly discovered reserves will be exhausted by 2100, if not far earlier. Of the 81 billion BOE produced each year from all energy sources, 86% or 70 billion BOE comes from non-renewable oil, coal, and natural gas. At this percentage, by 2100, the world would need about 240 billion BOE from oil, coal, and natural gas. With an annual average of about 155 billion BOE through the end of the century, the world would need about 14 ,100 billion BOE of oil, coal, and natural gas to reach the end of the century. Current proved recoverable reserves of oil, coal, and natural gas total only about 6 ,000 billion BOE. Expert estimates of additional recoverable reserves optimistically add another 6 ,000 billion BOE—for example, including nearly 3 ,000 billion BOE from all oil from oil shale—for a combined total of around 12 ,000 billion BOE. \* With increasing world energy consumption and if oil, coal, and natural gas continue to provide most of the world’s energy, known and new reserves of oil, coal, and natural gas will be exhausted by the end of the century, if not much earlier. To transform the world to primarily sustainable energy by 2100 to replace oil, coal, and natural gas, current sustainable energy sources must be scaled up from today by a factor of 24. By the end of the century—perhaps decades earlier—the world will need to obtain almost all of its energy from sustainable energy sources: nuclear and renewables. Today, the equivalent of about 11 billion BOE comes from sustainable energy sources. By 2100, the world must increase the production capacity of sustainable energy sources by a factor of about 24 to provide the equivalent of 280 billion BOE. The two primary sources of sustainable energy today are nuclear and hydroelectric. Today, the world has the sustainable energy equivalent of about 350 1-GWe (gigawattelectric) nuclear power plants and 375 2-GWe Hoover Dams. To meet the world’s 2100 need for 280 billion BOE of energy production, every four years through the end of the century, the world must add this amount of sustainable energy production in the form of nuclear, hydroelectric, geothermal, wind, solar, and biomass 5. Terrestrial sources of sustainable dispatchable electrical power generation will fall significantly short of U.S. and world needs by 2100 and, even, current U.S. needs. Energy is supplied in two primary forms: dispatchable electrical power to meet consumer needs for electricity and modern fuels to power transportation and other systems operating off the electrical power grid. By 2100, the world will need about 18 ,000 GWe of dispatchable electrical power generation capacity, compared with about 4,000 GW today, with almost all generated by sustainable sources. \* To assess the potential of nuclear fission and terrestrial renewables for meeting this world need, the addition of 1 ,400 1-GWe conventional nuclear fission reactors , the construction of the equivalent of 1 ,400 2 GWe Hoover Dams for added hydroelectric power generation, the addition of 1 ,900 GWe of geothermal electric power generation, and the expansion of wind-generated electrical power to 11 million commercial wind turbines, covering 1 .74 million sq. mi., would only be able to supply about 47% of the world’s 2100 need for dispatchable electrical power generation capacity. ‡ For the United States, only about 30% of the needed 2100 dispatchable electrical power generation capacity could be provided by these sustainable sources. By 2100, the U.S. and the world would be left with a dispatchable electrical power generation shortfall of 70% and 53%, respectively, with respect to this paper’s projection of the 2100 needs. Further, for the United States, the projected 2100 sustainable generation capacity would only provide about one-half of the current installed generation capacity that relies substantially on nonrenewable coal and natural gas Expanded conventional renewable sources of sustainable fuels—hydrogen, alcohol, bio-methane, and bio-solids—will not be able to meet the U.S.’s or the world’s 2100 needs for sustainable fuels. To assess the potential for conventional renewable sources of sustainable fuel for the entire world in 2100, hydrogen production from the electricity generated by nearly 600 ,000 sq. mi. of ground solar photovoltaic systems, hydrogen production from over 80% of the electrical power generated by 11 million wind turbines, and biofuels produced from 1 3,000 million tons of land biomass from the world’s croplands and accessible forestlands would only be able to supply about 37% of the world’s 2100 need for sustainable fuels. For the United States, by 2100, the situation is about the same with only about 39% of the 2100 needed fuels production capable of being provided from these conventional sustainable energy sources. As with sustainable electrical power generation, conventional sustainable U.S. fuels production at projected 2100 levels would fall well short of meeting current U.S. needs for fuel. Closing the U.S.’s and the world’s significant shortfalls in dispatchable electrical power will require substantial additional generation capacity that can only be addressed through the use of space solar power. Because of the substantial shortfall in needed 2100 fuels production, producing even more sustainable fuels to burn as a replacement for oil, coal, and natural gas to generate the needed additional electrical power is not practical. As a result, additional baseload electrical power generation capacity must be developed. The remaining potential sources of dispatchable electrical power generation are advanced nuclear energy and space solar power. While advanced nuclear energy certainly holds the promise to help fill this gap, fulfilling its promise has significant challenges to first overcome. Demonstrated safety; waste disposal; nuclear proliferation; fuel availability; and, for fusion and some fission approaches, required further technology development limit the ability to project significant growth in advanced nuclear electrical power generation. Space solar power (SSP)—involving the use of extremely large space platforms (20 ,000 or more tons each) in geostationary orbit (GEO) to convert sunlight into electrical power and transmit this power to large ground receivers—provides the remaining large-scale baseload alternative. Relying on SSP would require 1 ,854 5-GWe SSP systems to eliminate the world’s shortfall in needed 2100 dispatchable electrical power generation capacity. Of these, 244 SSP systems would be used to eliminate the U.S. shortfall in needed 2100 dispatchable electrical power generation capacity. The following two charts summarize this paper’s projection of the potential contribution of SSP in meeting the U.S.’s and the world’s dispatchable electrical power generation needs in 2100. 8. In addition to eliminating the dispatchable electrical power generation shortfall, SSP could, with algae biodiesel, eliminate the sustainable fuels production shortfall. Excess SSP electrical power can be used, when demand is less than the SSP generation capacity, to electrolyze water to produce hydrogen. Closed environment algae biodiesel production, done on the land under each SSP receiving antenna, combined with SSP hydrogen production can provide 24% and 19% of the United States’ and the world’s 2100 needed fuels production, respectively. The remaining fuels gap would be closed by warm-climate, open-pond algae biodiesel production. These two forms of sustainable fuels production—SSP hydrogen and algae biodiesel—would provide slightly more that 60% of this paper’s projection of the U.S.’s and the world’s 2100 needs for sustainable fuel production, as seen in the two charts below. Recognizing that the dedicated land area required in the United States to install the needed renewable energy production systems will be substantial, SSP provides one of the highest efficiencies in terms of renewable energy production capacity per sq. mi. of all the renewable alternatives. In the United States, 375,000 sq. mi.—about 12% of the continental United States—would be directly placed into use for renewable energy generation to meet this paper’s projection of 2100 energy needs. (For comparison, the U.S. arable and permanent cropland totals 680 ,000 sq. mi.) This land would be 100% covered with wind farms, ground solar photovoltaic systems, SSP receiving antennas, and open-pond algae biodiesel ponds. Of these four renewable energy options, SSP is one of the most land use efficient. The 244 SSP receiving antennas would require only about 20,000 sq. mi. or about 0.6% of the continental U.S., while providing nearly 70% of the dispatchable electrical power generation capacity and about 24% of the sustainable fuels production capacity by 2100. Key conclusions 1. Based on this assessment’s findings, a sound U.S. energy policy and implementation strategy should emphasize: Finding and producing more oil, coal, and natural gas to meet growing demand in order to minimize energy scarcity and price escalation during the generations-long transition to sustainable energy supplies; Adopting prudent energy conservation improvements to reduce the per capita energy needs of the United States, as well as the rest of the world, without involuntarily reducing the standard of living; Aggressively transitioning to conventional nuclear and terrestrial renewable energy sources to supplement and then replace oil, coal, and natural gas resources to avoid dramatic reductions in available per capita energy as non-renewable energy sources are exhausted this century; and, Aggressively developing advanced nuclear energy, space solar power energy, and open-pond/closed-environment algae biodiesel production to fill the substantial projected shortfalls in sustainable electrical power generation and fuels production that will develop even with optimistic levels of conventional nuclear and terrestrial renewable energy use. 2. While it is certainly easy to be disillusioned by these findings, this need not and should not be the case, especially in the United States. The world and the United States have successfully undergone a comparable transition in energy sources when wood was no longer sufficient to meet the growing needs of a rapidly industrializing world. When the transition to coal started in earnest in the 17 th century, steam power, electrical power, internal combustion, and nuclear energy where yet-to-be-invented new forms of energy conversion that now power the world. For about four centuries, technological development, economic investment, and industrial expansion— undertaken to realize the potential of “easy energy”—have been a foundation of the world’s growing standard of living and the emergence of the United States as a great power. Now, recognizing that the end of easy energy is at hand, the United States needs to aggressively move to expand existing sources of sustainable energy and develop and implement new sources to foster continued technological development, economic investment, and industrial expansion in the United States during the remainder of this century. It is critical that the United States take a leadership position in the development of space solar power as this may become the dominant electrical power generation capability for the world.

SPS solves energy wars – proximate cause of 21st century conflict

-even perception of shortage leads to conflict –

(good answer to “no resource wars” defense)

Dinerman 8 – DoD Consultant

[Taylor Dinerman, DoD Consultant, 9-15-2008, “War, peace, and space solar power,” Space Review, http://www.thespacereview.com/article/1209/1]

It was a little more than a month ago when the crisis in the Caucasus erupted. It will be years before historians sort out exactly how it started, but no one can deny that it ended with a classic case of Russia using massive military force to impose its will on a tiny but bothersome neighbor. In any case this little war has shocked the international space industry in more ways than one. While politicians in the US and Europe debate the best way to ensure access to the International Space Station (ISS), a more profound lesson from the crisis is evident. The world can no longer afford to depend upon easily disrupted pipelines for critical energy supplies. The one that ran from Azerbaijan through Georgia to Turkey was, no doubt, an important factor in setting off the events of August 2008. In the future other pipelines, such as the one that may run from the coast of Pakistan to western China, may be just as important and as vulnerable as the one that runs through Georgia. Removing this kind of infrastructure from its central role in the world’s energy economy would eliminate one of the most dangerous motivations for war that we may face in the 21st century. If the world really is entering into a new age of resource shortages—or even if these shortages are simply widely-held illusions—nations will naturally try their best to ensure that they will have free and reasonably priced access to the stuff they need to survive and to prosper. Some of the proposed regulations aimed at the climate change issue will inevitably make matters worse by making it harder for nations with large coal deposits to use them in effective and timely ways. The coming huge increase in demand for energy as more and more nations achieve “developed” status has been discussed elsewhere. It is hard to imagine that large powerful states such as China or India will allow themselves to be pushed back into relative poverty by a lack of resources or by environmental restrictions. The need for a wholly new kind of world energy infrastructure is not just an issue involving economics or conservation, but of war and peace. Moving a substantial percentage of the Earth’s energy supply off the planet will not, in and of itself, eliminate these kinds of dangers, but it will reduce them. Nations that get a large percentage of their electricity from space will not have to fear that their neighbors will cut them off from gas or coal supplies. The need for vulnerable pipelines and shipping routes will diminish.

These wars go global

Schubert 10 – PhD in electrical engineering

[Peter J. Schubert, PhD in electrical and computer engineering from Purdue University, holds 30 US patents, 8 foreign patents, and has published over 60 technical papers and book chapters, 12-2010, “Costs, Organization, and Roadmap for SSP,” Online Journal of Space Communication, http://spacejournal.ohio.edu/issue16/schubert.html]

For a miracle to occur the US must perceive a real and on-going threat. Considering the most problematic areas listed above gives guidance on what sort of threats may arise. Environmental events may be roughly divided into regional disasters lasting days, weeks, or years (tsunamis, hurricanes, droughts); or decimating global weather shifts lasting generations (megavolcanic eruptions, ice age, runaway thermal superstorms). Either type threatens SSP. Regional disasters draw down funding coffers to provide immediate relief and possibly rebuilding; while decimations reduce commerce such that long-term, high-cost projects are no longer affordable. The same logic holds true for nuclear events, whether localized (Hiroshima, Nagasaki, Chernobyl), or widespread and generational (global thermonuclear war). Energy shortages will drive prices until economic necessity overcomes free market forces, and wars erupt. These may be regional, lasting years; or they may escalate into a third Great War over scarce energy sources. None of these options favor SSP.

High costs are the biggest impediment to solar power satellites

Betancourt, ’10 -- Third-year student at the University of Maryland School of Law, specializing in environmental and international law

[Kiantar Betancourt, Space Based Solar Power: Worth the effort?, Space Energy, 8/28/10, http://spaceenergy.com/AnnouncementRetrieve.aspx?ID=56407]

The biggest challenge to SBSP is the high launch costs of getting its satellites into space. At current rate launching payloads into low-earth orbit costs $6k to $10k per kilogram.[77] The cost of SBSP at that rate would well exceed the cost of coal powered electricity of 8-10 cents per kilowatt.[78] Without any further improvement to current technology, to supply power at 8-10 cents per kilowatt, launch costs would need to fall as low as $440 per kilogram.[79] As the private space industry expands costs are expected to fall significantly in the coming decades.[80] Virgin Galactic, founded by Sir Richard Branson, and SpaceX, founded by Elon Musk, are two such companies working to lower to the cost of space travel.[81] SpaceX’s Falcon 1 rocket successfully reached orbit for the first time in Sept. 2008.[82] The company is developing a much larger rocket, Falcon 9, which will be capable of carrying payloads up to 12 tons into orbit.[83] Mr. Musk estimates the Falcon 9 could bring the launch costs down to $3k per kilo, and with reuse of each launcher eventually down to $1k per kilo.[84] High initial launch costs could also be alleviated if they were distributed amongst a larger group of participants joined by their interest in creating SBSP. If the NASA, ESA, and JAXA worked together the initial startup costs of SBSP could be distributed and would not place as great a burden on the individual parties. Such cooperation is not unprecedented. The International Space Station, a joint effort of 16 countries, has cost the U.S. and its partners over $100 billion dollars over the past 15 years.[85] A similar effort, for a price tag closer to 10 billion could see the development of the first prototype of SBSP.[86] If JAXA or a private company are able to complete the first working prototype the argument for SBSP will become even stronger. Prohibitive launch costs remain the number one technical and financial barrier to SBSP though it seems over time this problem will diminish. Improving the international legal framework governing space law is of equally important to the realization of SBSP.

SSP Adv. – UQ – Energy Consumption Increasing

Energy consumption will increase exponentially – leads to resource peaks

IAA 11

[International Academy of Astronautics, Academy that brings together the world's foremost experts in the disciplines of astronautics on a regular basis to recognize the accomplishments of their peers, and explores and discuss cutting-edge issues in space research and technology, 4-2011, “The First International Assessment of Space Solar Power: Opportunities, Issues and Potential Pathways Forward,” Green Energy From Space Solar Power, http://iaaweb.org/iaa/Scientific%20Activity/Study%20Groups/SG%20Commission%203/sg311/sg311finalreport.pdf]

There is now a tremendous need (and indeed for the remainder of this century) for the identification, development and deployment of new energy sources. This need is driven strictly by the demographics of Earth’s rising population. However, the technological approaches that are employed to meet that economically driven demand for energy will directly determine the potential climate impact (i.e., greenhouse gas emissions) that result. Moreover, there is the increasing likelihood – the timing of which is still uncertain – that the production of key fossil fuels will peak during the coming decades, resulting in further risks to the global economy and quality of life. Future Energy Demand Despite setbacks such as the current recession, economic growth during the coming decades will demand dramatic increases in the supply of energy worldwide – including energy primary heating/cooling, transportation, and especially electrical power generation. 3 Table 1-1 (see below) provides a summary of characteristic current forecasts of future energy and environmental factors that provide the global energy context for the IAA’s consideration of the space solar power option. Forecasts vary widely; however, a baseline would require two-times the level of energy consumption in 2010 by 2030-2040, and four-times that level by 2090-2100. Delivering that huge increase in energy will require massive development of new power plants, as well as new energy sources for transportation and other needs.

Resource peaks are inevitable – status quo renewables can’t fill in

Martin et al 11 – Lt. Col. in the USAF

[Harold Martin, et al, “Space Based Solar Power” Industry and Technology Assessment, Scholar]

Recent studies regarding “peak oil,” the time when the world oil supply reaches its highest volume before it declines, suggest a time frame between now and 2016, and multiple scenarios predict a 10% reduction in production by 2030 [8]. Oil makes up 29% of the current energy supply [9]. While these numbers suggest that oil will decrease at 0.005% per year, its actual decrease will not be gradual, but instead be a sudden precipitous drop over the course of only a few years [8], not giving the market enough time to develop a suitable alternative without having a destructive effect on the global economy. Coal, also makes up 29% of the current energy supply. “Peak coal” is estimated by academic sources to be reached in the next few years, and have been reduced to 50% of peak values by 2047 [10], though significant technological improvement in mining and refining low quality coal may reduce some of the effects. Producing 25% of the world’s sources of energy, natural gas is the only resource that is not expected to peak until 2020[11]. However, natural gas is not commonly shipped over ocean lanes, leading to a natural gas crisis currently in North America, as domestic (US and Canadian) production is not enough to meet demand, even with the use of environmentally destructive “shale gas” and other unconventional natural gas resources. North American peak natural gas could occur as early as 2013 [12]. Including the widespread use of environmentally destructive practices, North American gas production will only increase by 5% by 2025 [13]. Combining this data with data for total consumption gives us the following table[14]. The projections were all constructed using the standard Hubbert method, after which the overall changes were linearized and then extrapolated to 2025, as shown in the table below. Nuclear and renewables, discounting traditional biomass, currently accounts for 8.8% of the world energy supply. If we assume a low, basic growth in energy demand, by year 2025 there will need to be a 32% increase in energy supply. If we project a loss of 6.7% by 2025 from fossil fuels, there needs to be an amount of 38.7% of the current energy supply that comes from nuclear and renewables. This amounts to an increase of 12.8% per year from nuclear and renewables alone. While on the other hand, a 4% annual increase in energy demand would lead to a necessary 18.5% increase in the renewables and nuclear. Nuclear energy is approximately half the size of the renewable energy sources. Considering the difficulties there are in disposing of nuclear waste, and the recent problems with the nuclear facilities in Japan casting doubt on the safety of nuclear energy, it is unlikely that nuclear energy will be able to meet this increased demand. Furthermore, though currently renewable energy is increasing at a rapid rate, of around 20% over the renewables (mainly hydroelectric power) as a whole [14]. This indicates that there needs to be growth of a new source of energy in order to match such demand. Furthermore, as supply is not linear, but is instead expected to have sharp changes due to the Hubbert curve, a prepositioned alternative source of energy may have much to gain. According to studies by the United States Energy Information Administration, from 2007 to 2035, world net electricity generation is projected to increase by 87 percent, from 18.8 trillion kilowatt hours in 2007 to 25.0 trillion kilowatt hours in 2020 and 35.2 trillion kilowatt hours in 2035. In OECD countries, where electricity markets are well established and consumption patterns are mature, the growth of electricity demand is slower than in non-OECD countries, where a large amount of potential demand remains unmet. Total net generation in non-OECD countries increases by 3.3 percent per year on average, as compared with 1.1 percent per year in OECD nations. Total demand is expected to increase at 2 percent each year. World renewable energy use for electricity generation is projected to grow by an average of 3.0 percent per year and the renewable share of world electricity generation increases from 18 percent in 2007 to 23 percent in 2035.

SSP Adv. – Uniqueness / Link

Human consumption is poised to drastically increase – only space solar power can meet future demands

Johnson et al 9 – NASA Physicist

[Les Johnson, NASA Physicist, 2009, Matloff, PhD in Applied Science @ NYU, C Bangs, Artist, Paradise Regained: The Regreening of the Earth, pg. 108-109]

According to the United States Department of Energy, the average American household uses approximately 14,000 kilowatt-hours (kWh) per year. A kilowatt-hour is the amount of energy a 1-kilowatt appliance would use if left running for 1 hour. For example, a 100-watt light bulb burning for 1 hour would use 0.1 kWh; if it were left on for 10 hours, it would use 1 kWh. While this is currently far more power per person than that consumed by the citizens of the rest of the world, there is reason to believe that rest of the world's per capita energy consumption is rising and will continue to rise in the future as standards of living increase. Burning fossil fuels in automobiles, electrical power plants, or other machines like jet aircraft currently consumes most of this energy. We can convert sunlight directly into electrical power by using a solar cell. Solar cells use quantum mechanical effects to convert some fraction of the sun's energy railing on them to usable electrical power. Earth-based solar cells can be used effectively for applications that do not require a lot of power, like highway road signs and calculators. But if you need megawatts on a continual basis, solar cells are simply impractical in many locations. Terrestrial solar cells can generate power only during the day, only when the sun is not obscured by clouds and rain, and in locations that do not degrade the materials from which they are made. Unfortunately, there is no place on Earth that gets continuous sunlight and never has bad weather. What if you could locate these massive solar array farms in a location that is in almost perpetual sunlight with no cloudy or rainy days? You might have a chance at providing continuous power to an energy-hungry population without directly generating pollutants or emitting greenhouse gases. Then you might have a power solution worth considering. Space provides this optimal location to generate electricity for a power-hungry Earth.

SSP Adv. – 🡪Energy Independence

SSP leadership solves energy dependence

Shea 10 – MA in Public Policy from GWU

[Karen Shea, 12-2010, “Why Has SPS R&D Received So Little Funding?,” Online Journal of Space Communication, http://spacejournal.ohio.edu/issue16/shea.html]

The time is now for the development of space solar power. If the U.S. government commits to it as a matter of public policy, a new SPS industry will emerge, repaying the public investment many times over. If the U.S. does not do so, Japan, China, India or Russia will take the lead in space solar power development and the U.S. will continue to send billions of dollars a year abroad to insure that our energy needs are met.

US leadership is key to develop the industry and open the door for partnerships

JEN 7

[Japan Economic Newswire, “US Report urges space based solar power,” Lexis]

The United States should launch a small-scale satellite within 10 years to explore the viability of putting space-based solar power into commercial use by 2050, according to a recently released U.S. report. The recommendations on a project to develop space platforms capable of collecting energy from the sun and transmitting it back to Earth using microwave beams appear in the report compiled by the National Security Space Office, an affiliate of the Defense Department. "Space-based solar power does present a strategic opportunity that could significantly advance U.S. and partner security, capability and freedom of action, and merits significant further attention on the part of both the U.S. government and the private sector," the report said. "In addition to the emergence of global concerns over climate change, American and allied energy source security is now under threat from actors that seek to destabilize or control global energy markets," it added.

Specifically – a large US investment turns the US into a net energy exporter

Chapman et al 11 – geophysicist and astronautical engineer who served as a NASA scientist astronaut during the Apollo Program

[Phil Chapman, March, 2011, <http://solarhigh.org/Overview.html>]

The expected cost of deploying SBSP is ~$7,400/kW, including the rectenna as well as construction and launch of Block II satellites. Amortized over an expected life of 30 years at a discount rate of 5%, the contribution of this capital cost to the delivered cost of electric energy would be 5.6 cents/kWh. SBSP is thus much more promising than terrestrial solar as a replacement for fossil fuels or nuclear power. A strong US commitment to SBSP could solve the energy problem permanently, in the USA and around the world. Offer clean, inexhaustible solar power almost anywhere on Earth. Restore the status of the United States as an energy-exporting nation. Create large international markets for export of our technology as well as energy. Offer greatly reduced launch costs to all users of space, including the DoD, NASA and commercial interests. Restore US preeminence in launch services. Permit explosive growth in extraterrestrial enterprises. Open the solar system as the domain of our species, eliminating most concerns about resource exhaustion. Serious studies of SBSP are under way in several countries, including Japan, China, India and the European Union. Continued US neglect of this vital technology means that we will not only suffer all the economic, political and strategic consequences of abdicating our leadership in space but also abandon control of our energy future. What we do about these issues in the next few years will determine whether we will restore American initiative or become a debt-ridden, second-rate nation that must import electricity as well as petroleum**.**

SSP Adv. – 🡪 US Net Energy Exporter

Plan makes the US a net energy exporter

Nansen 2k - President of the Solar Space Industries

[Ralph Nansen, September 7, 2000, <http://www.nss.org/settlement/ssp/library/2000-testimony-RalphNansen.htm>]

Energy demand continues to grow as our population expands. The electronic age is totally reliant on electric power and is creating a new need for electric power. Many areas of the nation are experiencing energy shortages and significantly increased costs. United States electricity use is projected to increase by 32% in the next twenty years while worldwide electric energy use will grow by 75% in the same period. Worldwide oil production is projected to peak in the 2010 to 2015 time period with a precipitous decrease after that due to depletion of world reserves. Natural gas prices in the United States have doubled in the last year as the demand has grown for gas fired electrical generation plants. Global warming and the need for reduction of CO2 emissions calls for the replacement of fossil fuel power plants with renewable nonpolluting energy sources. Even with increased use of today's knowledge of renewable energy sources carbon emissions are expected to rise 62% worldwide by 2020. If we have any hope for a reversal of global warming we must dramatically reduce our use of fossil fuels. Solar power satellite development would reduce and eventually eliminate United States dependence on foreign oil imports. They would help reduce the international trade imbalance. Electric energy from solar power satellites can be delivered to any nation on the earth. The United States could become a major energy exporter. The market for electric energy will be enormous. Most important of all is the fact that whatever nation develops and controls the next major energy source will dominate the economy of the world. In addition there are many potential spin-offs. These include: Generation of space tourism. The need to develop low cost reusable space transports to deploy solar power satellites will open space to the vast economic potential of space tourism. Utilize solar power to manufacture rocket fuel on orbit from water for manned planetary missions. Provide large quantities of electric power on orbit for military applications. Provide large quantities of electric power to thrust vehicles into inter-planetary space. Open large-scale commercial access to space. The potential of space industrial parks could become a reality. Make the United States the preferred launch provider for the world.

More evidence

Foust 08 **–**Space Review editor and publisher,

[Jeff Foust ,The Space Review 9/15, http://www.thespacereview.com/article/1210/1]

Such efforts, though, are likely beyond the budgets of the Discovery Channel and other networks (not to mention that doing studies hardly makes for the most scintillating television), requiring funding from other sources, most likely the federal government, which is not currently funding any SSP-related research. A variety of government agencies, Mankins said, could step forward to support this, from the Defense Department to the Energy Department. “The $100 million could come from a variety of places, but the key thing is to have it actually focused on these problems,” he said. “The United States is by far the world’s greatest space power,” said Mark Hopkins, senior vice president of the NSS, “and yet we’re not spending any money in this country on space solar power.” That’s not the case in Europe and Japan, where there is money being spent, if only on a small scale, on SSP. “The situation is ridiculous.” One person working to try and make the case for SSP on Capitol Hill is Paul Rancatore. Earlier this year Rancatore ran for Congress from Florida’s 15th district, in the state’s “Space Coast” region and home to many people who work at the Kennedy Space Center. Rancatore made mention of SSP in his campaign, calling it “an economic generator not seen since the Apollo program” and winning the endorsement of Apollo 11 Buzz Aldrin. However, he lost the Democratic primary last month. Rancatore is now spending time meeting with members of Congress and their staffs, primarily with the House Committee on Energy and Commerce and the Select Committee on Energy Independence and Global Warming, on the issue of SSP. “Energy is probably the biggest issue facing the country as well as the world,” he said, requiring both short- and long-term solutions. SSP, he said, solves three major issues in the US today: employment, particularly in high-technology areas; energy independence; and foreign policy. Right now, Rancatore said he’s working to “educate members about what space-based solar power can do for our country, create that dialogue, and possible create a ‘space-based solar caucus’ within Congress for them to fully understand the ramifications for our country and the world and start get members involved.” In an interview after the press conference, he said he’s met with Congressman Ed Markey (D-MA), who chairs the global warming committee, about this issue. Rancatore said he’s yet to identify a member willing to champion this issue in Congress, but expects to make progress on that front, including establishing the caucus, when a new Congress convenes in January. He added that he’s reached out to the campaigns of John McCain and Barack Obama on this subject as well. Some of that rhetoric being used to win over members of Congress was trotted out at the press conference as well. “The potential of space solar power is so large that, if it works out, it would transform the American economy to a much greater extent than the auto industry did in the early part of the 20th century,” said Hopkins, who added that SSP could allow the US to stop spending hundreds of billions of dollars a year to import energy, some of it from countries unfriendly to the US. That’s the long-term goal, but for now the focus is on near-term incremental progress. “What we think we’ve done is to demonstrate that progress is possible,” Mankins said. “It’s possible in a short time and it’s possible at a reasonable budget.”

SSP Adv. -- 🡪 Solves Warming

SPS leads to climate stabilization and prevents ice age

Collins and Autino, ‘9 -- Life & Environmental Science, Azabu University, Japan, and Andromeda Inc., Italy [Patrick Collins\* & Adriano Autino\*\*, What the Growth of a Space Tourism Industry Could Contribute to Employment, Economic Growth, Environmental Protection, Education, Culture and World Peace, Originally presented at Plenary Session of the International Academy of Astronautics' 1st Symposium on Private Human Access to Space, held at Arcachon in France, 25-28 May 2008. Revised and updated 11 June 2009, http://www.spacefuture.com/archive/what\_the\_growth\_of\_a\_space\_tourism\_industry\_could\_contribute\_to\_employment\_economic\_growth\_environmental\_protection\_education\_culture\_and\_world\_peace.shtml]

The use of solar power satellites for reducing the severity of hurricanes and typhoons, and/or ameliorating severe snow conditions has been discussed for some years. In the extreme case this application of SSP might even include a role in the stabilisation of climate. Earth's climate system is extremely complex, and is the subject of a great deal of ongoing scientific research, including collection of an ever-wider range of data, and ever-more detailed analysis of climate change in the past. A positive-feedback cycle causing sudden onset of the cooling phase of the long-term cycle of "ice ages" has been hypothesized, whereby a winter with unusually low temperatures and/or unusually widespread and/or longlasting snow cover would increase the probability of the following winter being even more severe [28,29]. The beginning of such a trend would be similar to the sharply more severe winters seen over the two last years in North America (as well as the unusually cool 2009 summer). Consequently, although such a possibility may seem remote, and although there are thorny legal problems concerning deliberate weather modification, it is nevertheless noteworthy that satellite power stations may be the only practical means of selectively melting snow over areas of thousands of square kilometres, possibly sufficient to prevent such a vicious circle, even in the event of terrestrial energy shortages.

SSP Adv. – Resource Scarcity 🡺 War

Resource scarcity leads to war

Evans 10 - MA in Politics, MSc in Environment, Head of CIC Climate Change Department

[Alex Evans, MA in Politics, MSc in Environment, Head of CIC Climate Change Department, “Globalization and Scarcity,” http://www.cic.nyu.edu/scarcity/docs/evans\_multilateral\_scarcity.pdf]

Another risk is that scarcity shocks can lead to violent unrest. During the food and fuel price spike that peaked in 2008, for example, 61 countries experienced unrest as a result of price inflation. In 38 countries, these protests turned violent, with fragile states proving particularly susceptible to this problem. 105 More recently, as noted earlier in the paper, Mozambique experienced serious unrest in summer 2010 when it tried to reduce subsidies on bread, leaving seven people dead and over 200 injured. 106 At worst, scarcity may contribute to the outbreak or sustenance of violent conflict. Some quantitative studies have found strong causal relationships between rainfall variation or temperature increase and violent conflict, although the methodological approach taken by these studies has been challenged, and such quantitative approaches also rest on an implicit assumption that the past will be a guide to the future – which may be incorrect, given the potential for abrupt, non-linear changes in the future, as discussed in the section on climate change earlier in the paper. 107 Alternatively, cases can be identified in which scarcity has played a role, for instance competition for land in the run-up to the 1994 Rwandan genocide or the disputed elections in Kenya in 2008, or the role of both water and land as conflict threat multipliers in Ethiopia and Darfur. 108 In many cases, the risk of violent conflict that arises from resource scarcity has less to do with disputes over the control of natural resources themselves, than with the livelihoods that they enable. One widely discussed example of this is the example of piracy off the coast of Somalia, where it has been argued that depletion of fisheries due to over-exploitation by fleets from other countries has led to fishing communities taking up piracy as an alternative livelihoods strategy.

It’s the proximate cause of war

Nordas and Gleditsch 9 -\*MA in Politics, \*\*Professor of Political Science

[Ragnhild Nordas and Nils Gleditsch, 2009, “IPCC and the climate-conflict nexus,” http://www.humansecuritygateway.com/documents/IPRI\_IPCCClimateConflictNexus.pdf]

IPCC (2001) points out that ‘much has been written about the potential for international conflict (hot or cold) over water resources’, and then goes on to say that ‘where there are disputes, the threat of climate change is likely to exacerbate, rather than ameliorate, matters because of uncertainty about the amount of future resources that it engenders’ (p. 225). The reference used for this statement is Gleick (1998), who claims that ‘history shows that access to resources has been a proximate cause of war, resources have been both tools and targets of war, and environmental degradation and the disparity in the distribution of resources can cause major political controversy, tensions, and violence’ (p. 105). Furthermore, he also makes the claim that ‘the argument and focus of debate has now shifted from “whether” there is a connection to “when”, “where”, and “how” environmental and resources problems will affect regional and international security’ (p. 107).

SSP Adv. – Energy Crises 🡺 War

Energy conflicts have comparatively the highest impact

De Souza 11

[Mike De Souza, National affairs reporter; BA from Concordia University, “Energy-starved future looms, military warns” Postmedia News 4/18 http://www.vancouversun.com/technology/Energy+starved+future+looms+military+warns/4634442/story.html]

The planet is running out of oil and heading toward a future that could trap Canada in a violent spiral of decline in the economy and the environment, a special research unit within the Canadian military is predicting. This "global quagmire" is one of four possible future scenarios advanced by the six members of the team who are developing a plan for the army of tomorrow based on existing scientific research and analysis. In a best-case scenario, they predict that Canada could be at the forefront of a prosperous green economy, in which clean energy and environmental protection are priorities and living standards improve around the world. Two other scenarios fall in between, but all four alternatives conclude that energy security and global environmental change are the most serious and unpredictable factors that could radically alter society as well as the role of Canada's ar my. "It all depends on what kind of steps are taken today that could lead to various futures," Peter Gizewski, a strategic analyst on the team, told Postmedia News. Members of the team said that climate change in particular could have a wide range of consequences, as well as oil shortages in a world with no alternative sources of energy. "I don't think anybody would claim that we're all doomed in the sense that we're all going to face the same level," said Gizewski. "But there are parts of the world in some areas where armed conflict could occur that are particularly vulnerable to these things." The team has also noted that the world is now consuming oil faster than it's discovering it. "Globally, we find more (oil) all the time, but we haven't actually found as much as we've used in a given year since 1985," said Maj. John Sheahan, another member of the research team." Sheahan noted that the price of a full tank of gasoline, even at $100, is a bargain when compared to estimates in some research that it would be equivalent to about 25,000 people each doing one hour of work. The global quagmire scenario predicts a world ravaged by climate change and environmental degradation in which "markets are highly unstable" and there are high risks of widespread conflicts involving ownership and access to oil, water, food and other resources."Indeed, the danger of resource wars, both between and within states is acute," said a technical paper produced by the group in December. "Much of the violence occurs in the developing world, as dictators, organized crime groups and revolutionary movements fight for control of increasingly desperate societies. Yet developed countries are by no means immune from strife." In the best-case scenario, the team predicts that Canada could take a leadership role in the alternative energy and environmental fields after a series of technology sharing agreements with emerging economies and active support of developing sound international regimes and practices. Other drivers of change analyzed by the team were: the impact of age and demographics on military composition; exponential technology growth; human/social response to technology; expansion of operating environments; globalization; conflicting/shifting identities; power shifts; resource security; distribution of wealth and weapons proliferation. But members of the team said that energy security and environmental change are factors with the highest potential impacts

Empirical analysis proves

Rosen 10 – Professor of Law and Policy @ GWU

[Mark E. Rosen, Deputy General Counsel, CNA Corporation. LL.M., Univ of VA School of Law; J.D Univ of GA School of Law; A.B., Univ of GA.; has over 30 years of experience in the legal and national security fields, twenty-one year career as an international and maritime lawyer with United States Navy; teaches courses in Home-land Security Law and Policy at George Washington Univ School of Law and VA Polytechnic Institute, “Energy Independence and Climate Change: The Economic and National Security Consequences of Failing to Act” University of Richmond Law Review 3/16 http://lawreview.richmond.edu/energy-independence-and-climate-change-the-economic-and-national-security-consequences-of-failing-to-act/]

The seminal anthropological study by Jared Diamond provides historical support for the proposition that natural resource scarcity can lead to conflict that threatens U.S. security.[17] Diamond identified five contributing factors: environmental damage, climate change, hostile neighbors, friendly trade partners, and a society’s response to environmental problems that led to conflict among adjoining states and, ultimately, the risk of implosion leading to extinction.[18] Diamond asserts that [W]e shouldn’t be so naÃ¯ve to think that study of the past will yield simple solutions, directly transferable to our societies today. We differ from past societies in some respects that put us at lower risk than them; some of those respects often mentioned include our powerful technology (i.e., its beneficial effects), globalization, modern medicine, [etc.] . . . . We also differ from past societies in some respects that put us at greater risk than them: mentioned in that connection are, again, our potent technology (i.e., its unintended destructive effects), globalization (such that now a collapse even in remote Somalia affects the U.S. and Europe), the dependence of millions (and, soon, billions) of us on modern medicine for our survival, and our much larger human population. Perhaps we can still learn from the past, but only if we think carefully about its lessons.[19] Diamond’s anthropological study of the extinction of civilization on Easter Island in the South Pacific is a useful case study of the linkages between cultural decline and unsustainable use of carbon-based energy sources. Easter Island was blessed with a temperate climate and fertile soil as a result of volcanic activity.[20] However, the island’s temperateâ€”as opposed to tropicalâ€”climate and its geographic isolation meant that Easter Island was not endowed with as many fish species or freshwater supplies as some of its tropical counterparts.[21] Carbon dating of remains discloses that Easter Island was settled sometime around 900 A.D. and thrived until roughly 1700 A.D.[22] At one point, Easter Island had extensive agricultural activity, sophisticated systems for raising chicken and other livestock, incredible skill in stone masonry/engineering, and technology to construct large outriggers that could travel thousands of miles through the open ocean to engage in trade.[23] By the 1700s, however, the island’s populations of plants, wildlife, and people were in steep decline.[24] Diamond notes that during the good years, much of the island became increasingly deforested as the islanders consumed palms and hardwoods for various uses, including the manufacture of charcoal for heating and cooking.[25] By the 1400s almost all trees had disappeared.[26] Once the trees disappeared, the islanders were no longer able to construct boats for trade.[27] Wild sources of food were lost because there were no forests to sustain wildlife, and the population exploited fish stocks to extinction.[28] Agriculture also collapsed: the loss of forests led to top soil erosion and nutrient loss as crops were defenseless against wind and rain.[29] Starvation became the order of the day, leading to civil war, population crash, and cannibalism.[30] Captain Cook visited the island in 1774 and observed that the islanders were “small, lean, timid, and miserable.”[31] The number of home sites in the coastal region “declined by 70% from peak values around 1400â€“1600 to the 1700s. . . .”[32] By 1872, only 111 islanders were left on Easter, compared with a minimum population of 6000 to 8000 before the crash began.[33]

SSP Adv. – Energy Crises 🡺 Hotspots (Long)

Putting fossil fuels behind us solves global hotpots of conflict

Rosen 10

[Mark E Rosen., Deputy General Counsel, CNA Corporation. LL.M., Univ of VA School of Law; J.D Univ of GA School of Law; A.B., Univ of GA.; has over 30 years of experience in the legal and national security fields, twenty-one year career as an international and maritime lawyer with United States Navy; teaches courses in Home-land Security Law and Policy at George Washington Univ School of Law and VA Polytechnic Institute. (“Energy Independence and Climate Change: The Economic and National Security Consequences of Failing to Act” University of Richmond Law Review 3/16 http://lawreview.richmond.edu/energy-independence-and-climate-change-the-economic-and-national-security-consequences-of-failing-to-act/)]

There is a growing consensus in U.S. national security circles that American dependence on imported oil constitutes a threat to the United States because a substantial portion of those oil reserves are controlled by governments that have historically pursued policies inimical to U.S. interests. For example, Venezuela, which represents eleven percent of U.S. oil imports, “regularly espouses anti-American and anti-Western rhetoric both at home and abroad . . . [and] . . . promotes . . . [an] anti-U.S. influence in parts of Latin and South America . . .”[72] that retards the growth of friendly political and economic ties among the United States, Venezuela, and a few other states in Latin and South America. This scenario plays out in many different regions. Russia, for example, has used its oil leverage to exert extreme political pressure upon Ukraine and Belarus.[73] Longstanding Western commercial relations with repressive regimes in the Middle Eastâ€”i.e., Iran, Sudan, and Saudi Arabiaâ€”raise similar issues because of the mixed strategic messages that are being sent. Of course, large wealth transfers have allowed the Taliban in Saudi Arabia to bankroll terrorism.[74] A. Chokepoints and Flashpoints For the foreseeable future, the U.S. military will most likely be involved in protecting access to oil supplies â€”including the political independence of oil producersâ€”and the global movements of using oil to help sustain the smooth functioning of the world economy. The security challenges associated with preserving access to oil are complicated by geographical “chokepoints,” through which oil flows or is transported, but which are vulnerable to piracy or closure.[75] “Flashpoints” also exist as a result of politicalâ€”and sometimes militaryâ€”competition to secure commercial or sovereign access to oil in the face of disputed maritime and land claims that are associated with oil and gas deposits. Together, these challenges have necessitated that the United States and its allies maintain costly navies and air forces to protect sea lanes, ocean access, and maintain a presence to deter military competition in disputed regions. A selection of today’s chokepoints and flashpoints follow. The Strait of Hormuz. This strait is the narrow waterway that allows access from the Indian Ocean into the Persian Gulf. Two-thirds of the world’s oil is transported by ocean, and a very large percentage of that trade moves through Hormuz. The northern tip of Oman forms the southern shoreline of the strait.[76] Hormuz is protected by the constant transits of the U.S. Navy and its allies. Even though the strait has not been closed, the Persian Gulf has been the scene of extensive military conflict.[77] On September 22, 1980, Iraq invaded Iran, initiating an eight-year war between the two countries that featured the “War of the Tankers,” in which 543 ships, including the USS Stark, were attacked, while the U.S. Navy provided escort services to protect tankers that were transiting the Persian Gulf.[78] There have been past threats by Iran to militarily close the strait.[79] Additionally, there are ongoing territorial disputes between the United Arab Emirates and Iran over ownership of three islands that are located in approaches to the strait.[80] Closure of the strait would cause severe disruption in the movements of the world’s oil supplies and, at a minimum, cause significant price increases and perhaps supply shortages in many regions for the duration of the closure.[81] During the War of the Tankers, oil prices increased from $13 per barrel to $31 a barrel due to supply disruptions and other “fear” factors.[82] Bab el-Mandeb. The strait separates Africa (Djibouti and Eritrea) and Asia (Yemen), and it connects the Red Sea to the Indian Ocean via the Gulf of Aden. The strait is an oil transit chokepoint since most of Europe’s crude oil from the Middle East passes north through Bab el-Mandeb into the Mediterranean via the Suez Canal.[83] Closure of the strait due to terrorist activities or for political/military reasons, could keep tankers from the Persian Gulf from reaching the Suez Canal and Sumed Pipeline complex, diverting them around the southern tip of Africa (the Cape of Good Hope).[84] This would add greatly to transit time and cost, and would effectively tie-up spare tanker capacity. Closure of the Bab el-Mandeb would effectively block non-oil shipping from using the Suez Canal.[85] In October 2002 the French-flagged tanker Limburg was attacked off the coast of Yemen by terrorists.[86] During the Yom Kippur War in 1973, Egypt closed the strait as a means of blockading the southern Israeli port of Eilat.[87] The Turkish Straits and Caspian Oil. The term “Turkish Straits” refers to the two narrow straits in northwestern Turkey, the Bosporus and the Dardanelles, which connect the Sea of Marmara with the Black Sea on one side and the Aegean arm of the Mediterranean Sea on the other. Turkey and Russia have been locked in a longstanding dispute over passage issues involving the Turkish Straits.[88] The 1936 Montreux Convention puts Turkey in charge of regulating traffic through the straits;[89] yet Turkey has been hard pressed to stop an onslaught of Russian, Ukrainian, and Cypriot tankers, which transport Caspian Sea oil to markets in Western Europe.[90] Because of the very heavy shipping traffic and very challenging geography, there have been many collisions and groundings in the past, creating terrible pollution incidents and death.[91] Thus far, none of these incidents have been attributed to state-on-state-conflict or terrorism;[92] however, the confined waterway is an especially attractive target because of the grave economic and environmental damage that would result from a well-timed and well-placed attack on a loaded tanker. The issues surrounding the straits are also a subset of larger problems associated with the exploitation of Caspian oil, including severe pollution of the Caspian Sea as a result of imprudent extraction techniques, as well as the ever-present potential for conflict among the various claimants to the Caspian’s hydrocarbon resources due to an inability of the various Caspian littoral states to agree on their maritime boundariesâ€”and their legal areas in which to drill.[93**]** Any one of these problems could become a major flashpoint in the future**.** China vs. Japan. The Daiyu/Senkaku islands located in the East China Sea have become an increasingly contentious dispute because both claimants have, in the past, used modern military platforms to patrol the areas of their claims in which there are suspected oil and gas deposits in the seabed.[94] In September 2005, for example, China dispatched five warships to disputed waters surrounding its oil and gas platforms, which were spotted by a Japanese maritime patrol aircraft.[95] There have been other similar military-to-military encounters.[96] Given the fact that both countries have modern armed forces and are comparatively energy starved,it is not difficult to envision serious conflict erupting over these disputed areas. The Arctic Super Highway. Traditionalists would probably not include the Arctic as a security chokepoint. The oil connection is reasonably well known: “22 percent of the world’s undiscovered energy reserves are projected to be in the region (including 13 percent of the world’s petroleum and 30 percent of natural gas).”[97] However, given the very small margins that transporters earn transporting oil from point A to B,[98] shipping companies are always in search of shorter routes to transport oil to market. As the thawing of the Arctic Ocean continues as a result of climate change,[99] this may create new shipping routes that transporters of oil and other goods will use to maximize their profits and minimize their transit times. As supplies of readily exploitable crude oil are reduced, the probability increases that some of this trade will result from exploitation activities in the land and littoral areas adjacent to the Arctic Sea. This development is concerning for a number of reasons: (1) the area is very remote and could provide a safe haven to pirates seeking to hijack cargoes; (2) the environmental sensitivity of the area, and the concomitant difficulty of mounting a cleanup effort, means that an oil spill in that marine environment will be much more persistent than an oil spill in temperate waters;[100] (3) the Arctic presents unique navigational difficulties due to the lack of good charts, navigational aids, and communications towers, as well as the impacts of extreme cold on the operational effectiveness of systems;[101] (4) the unsettled nature of claims by various countries, including the United States, to the seabed continental shelf resources in the littoral areas off their coastlines creates the potential for military competition and conflict over these claims**.[**102] The International Maritime Organization (“IMO”) is now circulating draft guidelines for ships operating in Arctic areas to promoteâ€”but not requireâ€”ship hardening against an iceberg strike, better crew training, and environmental protection measures.[103] These guidelines are merely advisory and can only be implemented via the flag states.[104] Also, neither IMO nor any of the UN Law of the Sea Institutions have mandatory jurisdiction over any of the flashpoint issues relating to competing continental shelf claims in the Arctic,[105] meaning thatany disputes will remain unresolved for a long time. The above is only a selected list of potential flashpoints in which oil is the main culprit. Disputes between China and six other nations of the Spratly Islands, and other territories in the South China Sea, remain unresolved.[106] The Spratly Islands could become a flashpoint in the future, involving the United States or its allies, because of the proximity of those areas to the major sea routes to Japan and Korea.[107] The strategic straits of Malacca, Lombok, and Sunda in Southeast Asia are absolutely essential to the movement of raw materials to Japan, Korea, and China.[108] Because of Lombok’s depth and strategic location, it is a major transit route for very large crude carriers that move between the Middle East and Asia.[109] Lombok is an undefended waterway that is only eighteen kilometers in width at its southern opening, making it an attractive chokepoint for hijacking or eco-terrorism in which the waters of the environmentally sensitive Indonesian archipelago would be held hostage.[110]

SSP Adv. – High Launch Costs Prevent SSP

SSP Launches not cost competitive yet

Johnson et al 9 – NASA Physicist

[Les Johnson, NASA Physicist, 2009, Matloff, PhD in Applied Science @ NYU, C Bangs, Artist, Paradise Regained: The Regreening of the Earth, pg. 114-115]

Yes, there is always a catch. This virtually limitless, completely renewable, continuous power system will be expensive to develop and launch into space. The launch requirements alone, at today's prices, are astronomical (pun intended). A 4-gigawatt (GW) (4-billion-watt) power station would weigh in excess of 2 million kilograms and require perhaps twenty launches of NASA'S planned Ares-II rocket just to get the construction materials into space. Then it would have to be assembled, probably requiring humans since no matter how capable our robots may be, there is no substitute for having a person at the site in case something goes wrong. At today's prices, the launch costs alone could exceed $20 billion. (But with trillions of dollars being used in 2009 to bail out the world's financial institutions, this seems like a worthwhile and affordable investment!) Then there are the rest of the infrastructure costs. How much will it cost to build that spacecraft and solar arrays, the antennae, and the ground support equipment? These costs could easily total in the billions of dollars. For lack of detailed accounting analysis, let's say this infrastructure cost is on the order of half the launch cost, placing the total system price at approximately $30 billion. For comparison, using today's dollars, a coal-fired power plant would cost "only" hundreds of millions of dollars. Space-based solar power is clearly not cost competitive—yet. Improvements in solar array efficiency seem to be occurring on a regular basis. As of this writing, inventors are claiming efficiencies greater man 35 percent. Previous studies of space solar power assumed much lower efficiency solar cells, therefore requiring many more cells to produce the same amount of power as higher-efficiency ones. With these cells, the amount of mass to be carried to space will decline, resulting in a decline in the launch cost But it would have to decline dramatically to make a significant difference in the estimated multibillion-dollar cost. What can possibly make this affordable? Well, that all depends on the cost of energy and how much of a value we place on the environment. The cost of energy production is not as simple as dollars, euros, or yen. What is the cost to the planet of the strip mining required for the coal we burn in our thousands of power plants? What is the payoff in reduced defense spending that will result from us not having to depend on the volatile Middle East for oil to generate electrical power? How much is it worth to eliminate the acid rain associated with the burning of fossil fuels? What benefits will we reap from a power system mat produces no greenhouse gases? The authors contend that when the real societal costs are considered, as well as the real monetary cost from end to end, space-based solar power begins to look like a winner. It is an expensive winner, but a good investment nonetheless.

High launch costs impede space power

Oberg, ’99

[Jim Oberg, “Chapter 3- Impediments to the Exercise of Space Power,” Space Power Theory, 1999, p. 69]

High transportation cost is the primary inhibitor of expanded commercial, private, and even governmental activities in space. To some degree, however, this cost itself is a threshold, a barrier to easy access to space by second and third-tier players, whether governmental or non-governmental, whose presence would at the very least complicate, and at worst endanger, current activities. As this barrier lowers, there will be both good news and bad news for the United States. On a global scale, the gradual trend toward cheaper space launch technology will open the gates for several dozen more nations (or even corporations, institutes, or other associations) to acquire their own minimal orbital launch capability. Combined with advances in lightweight materials, electronics, and warheads, these capabilities will mean that within a few years, there will be dozens of players in low earth orbit capable of duplicating anything accomplished by the United States and the USSR in the 1960s. This includes manned spaceflight, unmanned earth observation payloads, communications relays and eavesdroppers, co-orbital antisatellite weapons, and even fractional or multiple orbit bombardment systems (both nuclear and conventional). For any nation wishing to wield a dominant role in the exercise of space power, the proliferation of players in space—with a much wider array of intentions and with much less predictable agendas—may be unpleasantly costly.

High launch costs prevent space power

Oberg, ’99

[Jim Oberg, “Chapter 3- Impediments to the Exercise of Space Power,” Space Power Theory, 1999, p. 67]

The exercise of the full range of space power is impeded by many factors, ranging from specific characteristics of space itself and modern space operations all the way through national and international issues. However, each of these limits is itself subject to amelioration through technological and policy development. Progress in each of these areas can lead to significant enhancement in a nation’s ability to exploit space power. The most obvious limitation on space operations is cost. In recent decades, little progress has been made in reducing the transportation cost per pound of placing payloads into orbit. This factor has distorted every other feature of space operations by limiting the size and number and accessible orbits of space objects. As a result of astronomical transportation costs, payloads must be optimized for weight and lifetime, which then drives up their price.

Space solar power only possible with lowered launch costs

Collins and Autino, ‘9 -- Life & Environmental Science, Azabu University, Japan, and Andromeda Inc., Italy

[Patrick Collins\* & Adriano Autino\*\*, What the Growth of a Space Tourism Industry Could Contribute to Employment, Economic Growth, Environmental Protection, Education, Culture and World Peace,

Originally presented at Plenary Session of the International Academy of Astronautics' 1st Symposium on Private Human Access to Space, held at Arcachon in France, 25-28 May 2008. Revised and updated 11 June 2009, http://www.spacefuture.com/archive/what\_the\_growth\_of\_a\_space\_tourism\_industry\_could\_contribute\_to\_employment\_economic\_growth\_environmental\_protection\_education\_culture\_and\_world\_peace.shtml]

Another potentially major space-based industry, which has been held back for 40 years by high launch costs, is the supply of solar power from space to Earth. Although the potential of this system was recognised in studies by the US Department of Energy in the late 1970s, and confirmed in the 1990s [13], total funding has remained minimal. However, progress could be rapid once launch costs fall to a few percent of ELV costs [14]. Hence, as passenger space travel activities expand to large scale, a growing range of manufacturing activities in Earth orbit, on the lunar surface and elsewhere could develop spontaneously, driven by entrepreneurial effort to exploit new business opportunities opened up by the growth of new commercial markets in Earth orbit. These will in turn open the door to the large-scale space activities described in [11].

Lower Launch costs 🡪 Solar Power Satellites

Collins and Autino, ‘9 -- Life & Environmental Science, Azabu University, Japan, and Andromeda Inc., Italy

[Patrick Collins\* & Adriano Autino\*\*, What the Growth of a Space Tourism Industry Could Contribute to Employment, Economic Growth, Environmental Protection, Education, Culture and World Peace,

Originally presented at Plenary Session of the International Academy of Astronautics' 1st Symposium on Private Human Access to Space, held at Arcachon in France, 25-28 May 2008. Revised and updated 11 June 2009, http://www.spacefuture.com/archive/what\_the\_growth\_of\_a\_space\_tourism\_industry\_could\_contribute\_to\_employment\_economic\_growth\_environmental\_protection\_education\_culture\_and\_world\_peace.shtml]

A second possibility, which has been researched for several decades but has not yet received funding to enable testing in orbit, is the delivery of continuous solargenerated power from space to Earth. Researchers believe that such space-based solar power ( SSP) could supply clean, low-cost energy on a large scale, which is a prerequisite for economic development of poorer countries, while avoiding damaging pollution. However, realisation of SSP requires much lower launch costs, which apparently only the development of a passenger space travel industry could achieve. Hence the development of orbital tourism could provide the key to realising SSP economically [14].

SSP Adv. – AT: Tech Not Ready

Zero technological barriers

Hsu 10 – PhD in Engineering

Feng, PhD in Engineering, Former head of the NASA GSFC risk management function, and was the GSFC lead on the NASA-MIT joint project for risk-informed decision-making support on key NASA programs, has over 90 publications and is coauthor of two books and co-chair of several technical committees, 12-2010, “Harnessing the Sun: Embarking on Humanity's Next Giant Leap,” Online Journal of Space Communication, http://spacejournal.ohio.edu/issue16/hsu.html

Why solar energy from space? Is it technologically feasible? Is it commercially viable? My answer is positively and absolutely yes. One of the reasons that less than one percent of the world's energy currently comes from the sun is due to high photovoltaic cell costs and PV inefficiencies in converting sunlight into electricity. Based on existing technology, a field of solar panels the size of the state of Vermont will be needed to power the electricity needs of the whole U.S. And to satisfy world consumption will require some one percent of the land used for agriculture worldwide. Hopefully this will change when breakthroughs are made in conversion efficiency of PV cells and in the cost of producing them, along with more affordable and higher capacity batteries. Roughly 7 to 20 times less energy can be harvested per square meter on earth than in space, depending on location. Likely, this is a principal reason why Space Solar Power has been under consideration for over 40 years. Actually, as early as 1890, inventor of wireless communication Nikola Tesla wrote about the means for broadcasting electrical power without wires. Tesla later addressed the American Institute of Electrical Engineers to discuss his attempts to demonstrate long-distance wireless power transmission over the surface of the earth. He said, "Throughout space there is energy. If static, then our hopes are in vain; if kinetic - and this we know it is for certain - then it is a mere question of time when men will succeed in attaching their machinery to the very wheel work of nature."[4] Dr. Peter Glaser first developed the concept of continuous power generation from space in 1968[5]. His basic idea was that satellites in geosynchronous orbit would be used to collect energy from the sun. The solar energy would be converted to direct current by solar cells; the direct current would in turn be used to power microwave generators in the gigahertz frequency range. The generators feed a highly directive satellite-borne antenna, which beamed the energy to earth. On the ground, a rectifying antenna (rectenna) converted the microwave energy to direct current, which, after suitable processing, was to be fed into the terrestrial power grid. A typical Solar Power Satellite unit - with a solar panel area of about 10 square km, a transmitting antenna of about 2 km in diameter, and a rectenna about 4 km in diameter - could yield more than1 GW electric power, roughly equivalent to the productive capability of a large scale unit of a nuclear power station. Two critical aspects that have motivated research into SPS systems are: 1) the lack of attenuation of the solar flux by the earth's atmosphere, and 2) the twenty-four-hour availability of the energy, except around midnight during the predictable periods of equinox. The Technological and Commercial Viability of SPS Among the key technologies of Solar Power Satellites are microwave generation and transmission techniques, wave propagation, antennas and measurement calibration and wave control techniques. These radio science issues cover a broad range, including the technical aspects of microwave power generation and transmission, the effects on humans and potential interference with communications, remote sensing and radio-astronomy observations. Is SPS a viable option? Yes, in my opinion, it can and should be a major source of base-load electricity generation powering the needs of our future. SPS satisfies each of the key criteria except for cost based on current space launch and propulsion technology. We all know that the expense of lifting and maneuvering material into space orbit is a major issue for future energy production in space. The development of autonomous robotic technology for on-orbit assembly of large solar PV (or solar thermal) structures along with the needed system safety and reliability assurance for excessively large and complex orbital structures are also challenges. Nevertheless, no breakthrough technologies or any theoretical obstacles need to be overcome for a solar power satellite demonstration project to be carried out. Our society has repeatedly overlooked (or dismissed) the potential of space based solar power. The U.S. government funded an SPS study totaling about 20 million dollars in the late 1970s at the height of the early oil crisis, and then practically abandoned this project with nearly zero dollars spent up to the present day. A government funded SPS demonstration project is overdue. Ralph Nansen, a friend of mine, who was the former project manager of the Apollo program at Boeing and who later managed the DOE-NASA funded SSP proof of concept study in the late 1970s, detailed the Boeing study in his excellent 1995 book Sun Power: The Global Solution for the Coming Energy Crisis[6]. In 2009, he authored another book entitled Energy Crisis: Solution From Space[7]. I highly recommend the reading of each of these two books for those interested in this topic. Of course, Dr. Peter Glaser's 1968 book and other papers[8] are superb reading on this topic as well. What I really want to point out here is that we can solve the cost issue and make Solar Power Satellites a commercially viable energy option. We can do this through human creativity and innovation on both technological and economic fronts. Yes, current launch costs are critical constraints. However, in addition to continuing our quest for low cost RLV (reusable launch vehicle) technologies, there are business models for overcoming these issues.

SSP Adv. – AT: Debris DA – Not Insurmountable

No debris DA

IAA 11

[International Academy of Astronautics, Academy that brings together the world's foremost experts in the disciplines of astronautics on a regular basis to recognize the accomplishments of their peers, and explores and discuss cutting-edge issues in space research and technology, 4-2011, “The First International Assessment of Space Solar Power: Opportunities, Issues and Potential Pathways Forward,” Green Energy From Space Solar Power, http://iaaweb.org/iaa/Scientific%20Activity/Study%20Groups/SG%20Commission%203/sg311/sg311finalreport.pdf]

Some of the important policy considerations examined included (1) the overall international regime (e.g., the Outer Space Treaty) that will comprise the framework for space solar power development; (2) various international legal requirements (e.g., the ITU, and space debris mitigation guidelines) with which SPS must comply; and, (3) relevant national legislation and regulations (such as ITAR in the US and similar rules in other countries). Detailed topics examined included (1) WPT beam health and safety considerations; (2) WPT spectrum allocation and management; (3) space debris considerations; and, (4) potential weaponization concerns. None of these factors appears to be insurmountable for SPS R&D eventual deployment. However, each of these (and others) will require appropriate attention during the early phases of SPS development. This is particularly true with respect to issues related to WPT beam safety and possible weaponization.

SSP Adv. – AT: Debris DA – Too High

Too high for space junk

Boerman 9 – Solaren’s Director of Energy Services

[Cal Boerman, Solaren's Director of Energy Services, Plans for solar power from outer space move forward, 2009, Daily Finance, http://www.dailyfinance.com/2009/09/26/plans-for-solar-power-from-outer-space-move-forward/]

Won't the signals hurt birds or knock down planes? See full article from DailyFinance: http://srph.it/iW12TM Not at all. The effects of RF signals on the human beings and birds and airplanes are well understood. We know what the safety standards are. We've been transmitting things this way for a long time. We need to make sure that our signal is controlled. The effect of RF energy on the human body is a heating effect. The energy levels we'll be working with are a lot less than you might feel if you were sitting out in the midday because the beam will be spread out over a very wide areas. The receiving antenna on the ground will be a couple of square miles. It's a big area but that means the beams are at lower concentration. As for airplanes, they would feel more heat coming out from under clouds than they would entering our beam. Remember, the satellites are 22,000 miles up, far above where planes or birds fly. We're so high up that even space junk is not an issue.

SPS can be portable and spends of its life in GEO – solves the impact

IAA 11

[International Academy of Astronautics, Academy that brings together the world's foremost experts in the disciplines of astronautics on a regular basis to recognize the accomplishments of their peers, and explores and discuss cutting-edge issues in space research and technology, 4-2011, “The First International Assessment of Space Solar Power: Opportunities, Issues and Potential Pathways Forward,” Green Energy From Space Solar Power, http://iaaweb.org/iaa/Scientific%20Activity/Study%20Groups/SG%20Commission%203/sg311/sg311finalreport.pdf]

Space Debris Considerations Policy Issue Summary. An issue that has increased dramatically in importance since the 1970s is that of space debris. The principal regime in which orbital debris is found is that of LEO – due largely to ETO transportation-derived fragments. There are three aspects to this issue for SPS. The first issue is the potential impact of LEO debris on dedicated SPS infrastructure. The second issue is the potential production of LEO debris by SPS ETO and in-space transportation. Finally, the third issue is the potential interaction of GEO SPS in-space transportation with LEO debris. Potential Impact of LEO Debris on SPS Infrastructure. The existing significant space debris environment in low Earth orbit (LEO) places significant operational constraints on concepts and operations for future SPS infrastructures. In particular, it is evident that SPS systems can spend only a limited period of time in LEO before being transported beyond to higher, safer orbits. Potential Production of LEO Debris by SPS Transportation. At the same time SPS transportation to space and operations in LEO are at some risk due to LEO space debris, it is also critical that the R&D to development systems concepts and supporting ETO and in-space transportation must consider carefully the possible production of additional debris in LEO. Given the immense scale of SPS operations, it is evident that SPS systems and infrastructures must be designed and developed to minimize the production of space debris under normal circumstances, and to be “failsafe” vis-à-vis space debris in the event of a mishap. Interaction of the GEO SPS and Space Debris. The risk due to space debris is significantly less in GEO than it is in LEO. However, as in the case of LEO given the immense scale of SPS operations in GEO, it is evident that SPS systems and infrastructures must be designed and developed to minimize the production of space debris under normal circumstances, and to be “fail-safe” vis-à-vis space debris in the event of a mishap. In this light, the standard practice of removing a failed GEO satellite by simply boosting it slightly outside of that orbit is clearly unacceptable. SPS in GEO must be developed to incorporate proactive containment and essentially permanent disposition of any failed system elements. Assessment of Impact(s). The overall impact of this policy / technical issue on SPS concept options should be readily managed. The greater the degree of modularity in the SPS concept, the less vulnerable the overall SPS platform will be to an ill-timed space debris impact; contrary-wise, the greater the degree to which the SPS platform is monolithic and its elements unique during transportation, then the greater the degree of vulnerability of the platform concept to space debris.

Not susceptible to debris

Grey 2k

[Jerry, Director of AIAA, Federal News Service, Congressional Testimony, 9-7-2000, Lexis]

(2) Orbital Debris. Although the SSP configurations are large, their diaphanous nature and location in geostationary or geosynchronous halo orbits imply low susceptibility to serious damage by either natural or anthropogenic orbital debris. Moreover, since all the proposed concepts employ robotic inspection and maintenance, repairs of any such damage should be able to be accomplished.

SSP Adv. – AT: Debris DA – SPS Solves Debris

SPS solves debris

Grey 2k

[Jerry, Director of AIAA, Federal News Service, Congressional Testimony, 9-7-2000, Lexis]

The AIAA assessment suggested a number of opportunities for multiple use of the SSP-enabling technologies in terrestrial and space endeavors Of these, the following high-priority areas were identified: (1) Human space exploration. (a) Power systems for the Martian surface. If nuclear systems turn out not be available for use, large photovoltaic arrays in the 100 - 200 kWe range, coupled with wireless power transmission (WPT), become highly promising.These solar power systems are especially attractive if they can be combined with an Earth-Mars transportation system using solar- electric propulsion (SEP). (b) In-space transportation. SEP is generally considered a viable alternative to nuclear thermal propulsion for human Mars exploration. (c) Beamed power. WPT could be used for mobile extraction systems deployed in permanently-shadowed cold traps at the lunar poles and for in-situ resource utilization at various locations on Mars. Other applications include beamed power to communications and information- gathering stations on planetary surfaces or in orbit; e.g., high-power radar mappers; mobile robotic systems; remote sensing stations; dispersed habitation modules; human-occupied field stations; and supplementary power to surface solar power systems during periods when they are shadowed. (2) Science and robotic space exploration (a) Multi-asteroid sample return. Visit a significant number of belt asteroids in a 2-5 year period, collecting samples for return to Earth. (b) Asteroid/comet analysis. Determine the chemical content of comets and asteroids on rendezvous missions (enabled by solar-electric propulsion) by using deep-penetration imaging radar and by beaming laser and/or microwave power down to the surface to vaporize material for spectrographic analysis. (c) Orbital debris removal. Use beamed energy to rendezvous and grapple with a piece of space junk. Space-based lasers could also be used to vaporize smaller debris or to redirect the orbits of larger pieces to atmospheric reentry trajectories. (d) Weapons-oriented demonstrations. Fire a high-energy laser from a lunar orbiter at the lunar surface to vaporize and excite surface materials, determining their chemical composition with a spectrometer aboard the orbiter. (e) In-space transportation. Use SEPS for a wide variety of science missions, also using WPT for sensor deployment via laser sails, laser- thermal propulsion, and laser-electric propulsion. (f) International space station (ISS). Replace ISS solar arrays using advanced SSP technologies, and use WPT for co-orbiting experiment platforms. (g) Radar and radiometer mappers. Use high-power planetary probes to conduct radar mapping of planetary surfaces and high-power radiometer surveys for comprehensive scientific studies of planetary environments. (h) Rovers. Deploy many small rovers on lunar and planetary surfaces using WPT. (i) Networked sensor systems. Use hundreds of tiny WPT-powered sensors to conduct detailed four-dimensional surveys of interplanetary and other space regions.

\*\*\*\*Commerce/Competitiveness Adv. \*\*\*\*

Competitiveness 1AC Adv.

First, American aerospace industry is declining

McLane, ’10 [James C., Associate Fellow in the American Institute of Aeronautics and Astronautics, his writings in support of a human presence on Mars have appeared in Harper’s and other major magazines around the world; “Mars as the key to NASA’s future,” June 1, 2010; <http://www.thespacereview.com/article/1635/1>]

The American aerospace industry seems oblivious to a unique business situation that offers the greatest potential in its history for long-term profit. Since the end of the Cold War, our aerospace firms have struggled to remain viable in the face of fickle government contracts, staffing challenges, and foreign competition. America has no shortage of inventors; indeed we may offer the world’s best cradle for innovation, but our aerospace companies are straining to hold on in the global marketplace. It’s tough today for US aerospace companies to maintain a competent technical staff since foreigners (traditionally a major source of new engineers) can now stay home, be educated, and find good jobs without ever leaving their country of birth. Places once called “third world” now support thriving aerospace concerns. Meanwhile, Americans are understandably reluctant to enter a field where long, hard university study qualifies a person for an unstable job with a mediocre salary. Many aerospace professionals circulate around the US like migrant farm workers, employed by whichever firm has the latest military contract. However, it’s costly and difficult to relocate to a new job in a different state every few years. Two-income families are common today so moving requires that a working wife or husband quit their job to follow their spouse. Family assets are usually tied up in relatively illiquid houses that add further complications. The constantly increasing development time for modern aircraft and military weapon systems typically result in huge program cost increases over original budget estimates.

Other countries are beginning to offer cheaper launches—US is losing out

Futron ‘5

[Futron Corporation, Technology management consulting firm. Futron applies analytically rigorous decision-support methods to transform data into information.The Declining U.S. Role in the Commercial Launch Industry, June 2005, p. 1]

Beyond the short-term variations, however, some long-term trends can be discerned. One of the more worrisome trends, from a U.S. perspective, has been the declining influence of American vehicles in the global commercial launch market. Once one of the dominant players in the marketplace, the market share of U.S.-manufactured vehicles has declined because of the introduction of new vehicles and new competitors, such as Russia, which can offer launches at lower prices and/or with greater performance than their American counterparts. Moreover, with commercial launch demand, particularly for larger vehicles, forecast to be relatively flat for the foreseeable future, and with still more new vehicles entering the market, there is little evidence that U.S.-built vehicles can win back most of the market share they have lost in recent years.

Competitiveness is the key internal link to U.S. primacy-gains in science and technology leadership are necessary to confront challenges

Segal, 2004 [Adam, Maurice R. Greenberg Senior Fellow in China Studies at the Council on Foreign Relations and the author of Digital Dragon: High Technology Enterprises in China, December; Is America Losing its Edge?, Foreign Affairs]

The United States' global primacy depends in large part on its ability to develop new technologies and industries faster than anyone else. For the last five decades, U.S. scientific innovation and technological entrepreneurship have ensured the country's economic prosperity and military power. It was Americans who invented and commercialized the semiconductor, the personal computer, and the Internet; other countries merely followed the U.S. lead. Today, however, this technological edge-so long taken for granted-may be slipping, and the most serious challenge is coming from Asia. Through competitive tax policies, increased investment in research and development (R&D), and preferential policies for science and technology (S&T) personnel, Asian governments are improving the quality of their science and ensuring the exploitation of future innovations. The percentage of patents issued to and science journal articles published by scientists in China, Singapore, South Korea, and Taiwan is rising. Indian companies are quickly becoming the second-largest producers of application services in the world, developing, supplying, and managing database and other types of software for clients around the world. South Korea has rapidly eaten away at the U.S. advantage in the manufacture of computer chips and telecommunications software. And even China has made impressive gains in advanced technologies such as lasers, biotechnology, and advanced materials used in semiconductors, aerospace, and many other types of manufacturing. Although the United States' technical dominance remains solid, the globalization of research and development is exerting considerable pressures on the American system. Indeed, as the United States is learning, globalization cuts both ways: it is both a potent catalyst of U.S. technological innovation and a significant threat to it. The United States will never be able to prevent rivals from developing new technologies; it can remain dominant only by continuing to innovate faster than everyone else. But this won't be easy; to keep its privileged position in the world, the United States must get better at fostering technological entrepreneurship at home.

Loss of Hegemony leads to nuclear war

Kagan, 2007 (Robert, senior fellow at the Carnegie Endowment for International Peace, “End of Dreams, Return of History”, 7/19, http://www.realclearpolitics.com/articles/2007/07/end\_of\_dreams\_return\_of\_histor.html)

This is a good thing, and it should continue to be a primary goal of American foreign policy to perpetuate this relatively benign international configuration of power. The unipolar order with the United States as the predominant power is unavoidably riddled with flaws and contradictions. It inspires fears and jealousies. The United States is not immune to error, like all other nations, and because of its size and importance in the international system those errors are magnified and take on greater significance than the errors of less powerful nations. Compared to the ideal Kantian international order, in which all the world's powers would be peace-loving equals, conducting themselves wisely, prudently, and in strict obeisance to international law, the unipolar system is both dangerous and unjust. Compared to any plausible alternative in the real world, however, it is relatively stable and less likely to produce a major war between great powers. It is also comparatively benevolent, from a liberal perspective, for it is more conducive to the principles of economic and political liberalism that Americans and many others value. American predominance does not stand in the way of progress toward a better world, therefore. It stands in the way of regression toward a more dangerous world. The choice is not between an American-dominated order and a world that looks like the European Union. The future international order will be shaped by those who have the power to shape it. The leaders of a post-American world will not meet in Brussels but in Beijing, Moscow, and Washington. The return of great powers and great games If the world is marked by the persistence of unipolarity, it is nevertheless also being shaped by the reemergence of competitive national ambitions of the kind that have shaped human affairs from time immemorial. During the Cold War, this historical tendency of great powers to jostle with one another for status and influence as well as for wealth and power was largely suppressed by the two superpowers and their rigid bipolar order. Since the end of the Cold War, the United States has not been powerful enough, and probably could never be powerful enough, to suppress by itself the normal ambitions of nations. This does not mean the world has returned to multipolarity, since none of the large powers is in range of competing with the superpower for global influence. Nevertheless, several large powers are now competing for regional predominance, both with the United States and with each other. National ambition drives China's foreign policy today, and although it is tempered by prudence and the desire to appear as unthreatening as possible to the rest of the world, the Chinese are powerfully motivated to return their nation to what they regard as its traditional position as the preeminent power in East Asia. They do not share a European, postmodern view that power is passé; hence their now two-decades-long military buildup and modernization. Like the Americans, they believe power, including military power, is a good thing to have and that it is better to have more of it than less. Perhaps more significant is the Chinese perception, also shared by Americans, that status and honor, and not just wealth and security, are important for a nation. Japan, meanwhile, which in the past could have been counted as an aspiring postmodern power -- with its pacifist constitution and low defense spending -- now appears embarked on a more traditional national course. Partly this is in reaction to the rising power of China and concerns about North Korea 's nuclear weapons. But it is also driven by Japan's own national ambition to be a leader in East Asia or at least not to play second fiddle or "little brother" to China. China and Japan are now in a competitive quest with each trying to augment its own status and power and to prevent the other 's rise to predominance, and this competition has a military and strategic as well as an economic and political component. Their competition is such that a nation like South Korea, with a long unhappy history as a pawn between the two powers, is once again worrying both about a "greater China" and about the return of Japanese nationalism. As Aaron Friedberg commented, the East Asian future looks more like Europe's past than its present. But it also looks like Asia's past. Russian foreign policy, too, looks more like something from the nineteenth century. It is being driven by a typical, and typically Russian, blend of national resentment and ambition. A postmodern Russia simply seeking integration into the new European order, the Russia of Andrei Kozyrev, would not be troubled by the eastward enlargement of the EU and NATO, would not insist on predominant influence over its "near abroad," and would not use its natural resources as means of gaining geopolitical leverage and enhancing Russia 's international status in an attempt to regain the lost glories of the Soviet empire and Peter the Great. But Russia, like China and Japan, is moved by more traditional great-power considerations, including the pursuit of those valuable if intangible national interests: honor and respect. Although Russian leaders complain about threats to their security from NATO and the United States, the Russian sense of insecurity has more to do with resentment and national identity than with plausible external military threats. 16 Russia's complaint today is not with this or that weapons system. It is the entire post-Cold War settlement of the 1990s that Russia resents and wants to revise. But that does not make insecurity less a factor in Russia 's relations with the world; indeed, it makes finding compromise with the Russians all the more difficult. One could add others to this list of great powers with traditional rather than postmodern aspirations. India 's regional ambitions are more muted, or are focused most intently on Pakistan, but it is clearly engaged in competition with China for dominance in the Indian Ocean and sees itself, correctly, as an emerging great power on the world scene. In the Middle East there is Iran, which mingles religious fervor with a historical sense of superiority and leadership in its region. 17 Its nuclear program is as much about the desire for regional hegemony as about defending Iranian territory from attack by the United States. Even the European Union, in its way, expresses a pan-European national ambition to play a significant role in the world, and it has become the vehicle for channeling German, French, and British ambitions in what Europeans regard as a safe supranational direction. Europeans seek honor and respect, too, but of a postmodern variety. The honor they seek is to occupy the moral high ground in the world, to exercise moral authority, to wield political and economic influence as an antidote to militarism, to be the keeper of the global conscience, and to be recognized and admired by others for playing this role. Islam is not a nation, but many Muslims express a kind of religious nationalism, and the leaders of radical Islam, including al Qaeda, do seek to establish a theocratic nation or confederation of nations that would encompass a wide swath of the Middle East and beyond. Like national movements elsewhere, Islamists have a yearning for respect, including self-respect, and a desire for honor. Their national identity has been molded in defiance against stronger and often oppressive outside powers, and also by memories of ancient superiority over those same powers. China had its "century of humiliation." Islamists have more than a century of humiliation to look back on, a humiliation of which Israel has become the living symbol, which is partly why even Muslims who are neither radical nor fundamentalist proffer their sympathy and even their support to violent extremists who can turn the tables on the dominant liberal West, and particularly on a dominant America which implanted and still feeds the Israeli cancer in their midst. Finally, there is the United States itself. As a matter of national policy stretching back across numerous administrations, Democratic and Republican, liberal and conservative, Americans have insisted on preserving regional predominance in East Asia; the Middle East; the Western Hemisphere; until recently, Europe; and now, increasingly, Central Asia. This was its goal after the Second World War, and since the end of the Cold War, beginning with the first Bush administration and continuing through the Clinton years, the United States did not retract but expanded its influence eastward across Europe and into the Middle East, Central Asia, and the Caucasus. Even as it maintains its position as the predominant global power, it is also engaged in hegemonic competitions in these regions with China in East and Central Asia, with Iran in the Middle East and Central Asia, and with Russia in Eastern Europe, Central Asia, and the Caucasus. The United States, too, is more of a traditional than a postmodern power, and though Americans are loath to acknowledge it, they generally prefer their global place as "No. 1" and are equally loath to relinquish it. Once having entered a region, whether for practical or idealistic reasons, they are remarkably slow to withdraw from it until they believe they have substantially transformed it in their own image. They profess indifference to the world and claim they just want to be left alone even as they seek daily to shape the behavior of billions of people around the globe. The jostling for status and influence among these ambitious nations and would-be nations is a second defining feature of the new post-Cold War international system. Nationalism in all its forms is back, if it ever went away, and so is international competition for power, influence, honor, and status. American predominance prevents these rivalries from intensifying -- its regional as well as its global predominance. Were the United States to diminish its influence in the regions where it is currently the strongest power, the other nations would settle disputes as great and lesser powers have done in the past: sometimes through diplomacy and accommodation but often through confrontation and wars of varying scope, intensity, and destructiveness. One novel aspect of such a multipolar world is that most of these powers would possess nuclear weapons. That could make wars between them less likely, or it could simply make them more catastrophic. It is easy but also dangerous to underestimate the role the United States plays in providing a measure of stability in the world even as it also disrupts stability. For instance, the United States is the dominant naval power everywhere, such that other nations cannot compete with it even in their home waters. They either happily or grudgingly allow the United States Navy to be the guarantor of international waterways and trade routes, of international access to markets and raw materials such as oil. Even when the United States engages in a war, it is able to play its role as guardian of the waterways. In a more genuinely multipolar world, however, it would not. Nations would compete for naval dominance at least in their own regions and possibly beyond. Conflict between nations would involve struggles on the oceans as well as on land. Armed embargos, of the kind used in World War i and other major conflicts, would disrupt trade flows in a way that is now impossible. Such order as exists in the world rests not merely on the goodwill of peoples but on a foundation provided by American power. Even the European Union, that great geopolitical miracle, owes its founding to American power, for without it the European nations after World War ii would never have felt secure enough to reintegrate Germany. Most Europeans recoil at the thought, but even today Europe 's stability depends on the guarantee, however distant and one hopes unnecessary, that the United States could step in to check any dangerous development on the continent. In a genuinely multipolar world, that would not be possible without renewing the danger of **world war.** People who believe greater equality among nations would be preferable to the present American predominance often succumb to a basic logical fallacy. They believe the order the world enjoys today exists independently of American power. They imagine that in a world where American power was diminished, the aspects of international order that they like would remain in place. But that 's not the way it works. International order does not rest on ideas and institutions. It is shaped by configurations of power. The international order we know today reflects the distribution of power in the world since World War ii, and especially since the end of the Cold War. A different configuration of power, a multipolar world in which the poles were Russia, China, the United States, India, and Europe, would produce its own kind of order, with different rules and norms reflecting the interests of the powerful states that would have a hand in shaping it. Would that international order be an improvement? Perhaps for Beijing and Moscow it would. But it is doubtful that it would suit the tastes of enlightenment liberals in the United States and Europe. The current order, of course, is not only far from perfect but also offers no guarantee against major conflict among the world's great powers. Even under the umbrella of unipolarity, regional conflicts involving the large powers may erupt. War could erupt between China and Taiwan and draw in both the United States and Japan. War could erupt between Russia and Georgia, forcing the United States and its European allies to decide whether to intervene or suffer the consequences of a Russian victory. Conflict between India and Pakistan remains possible, as does conflict between Iran and Israel or other Middle Eastern states. These, too, could draw in other great powers, including the United States. Such conflicts may be unavoidable no matter what policies the United States pursues. But they are more likely to erupt if the United States weakens or withdraws from its positions of regional dominance. This is especially true in East Asia, where most nations agree that a reliable American power has a stabilizing and pacific effect on the region. That is certainly the view of most of China 's neighbors. But even China, which seeks gradually to supplant the United States as the dominant power in the region, faces the dilemma that an American withdrawal could unleash an ambitious, independent, nationalist Japan. In Europe, too, the departure of the United States from the scene -- even if it remained the world's most powerful nation -- could be destabilizing. It could tempt Russia to an even more overbearing and potentially forceful approach to unruly nations on its periphery. Although some realist theorists seem to imagine that the disappearance of the Soviet Union put an end to the possibility of confrontation between Russia and the West, and therefore to the need for a permanent American role in Europe, history suggests that conflicts in Europe involving Russia are possible even without Soviet communism. If the United States withdrew from Europe -- if it adopted what some call a strategy of "offshore balancing" -- this could in time increase the likelihood of conflict involving Russia and its near neighbors, which could in turn draw the United States back in under unfavorable circumstances. It is also optimistic to imagine that a retrenchment of the American position in the Middle East and the assumption of a more passive, "offshore" role would lead to greater stability there. The vital interest the United States has in access to oil and the role it plays in keeping access open to other nations in Europe and Asia make it unlikely that American leaders could or would stand back and hope for the best while the powers in the region battle it out. Nor would a more "even-handed" policy toward Israel, which some see as the magic key to unlocking peace, stability, and comity in the Middle East, obviate the need to come to Israel 's aid if its security became threatened. That commitment, paired with the American commitment to protect strategic oil supplies for most of the world, practically ensures a heavy American military presence in the region, both on the seas and on the ground. The subtraction of American power from any region would not end conflict but would simply change the equation. In the Middle East, competition for influence among powers both inside and outside the region has raged for at least two centuries. The rise of Islamic fundamentalism doesn't change this. It only adds a new and more threatening dimension to the competition, which neither a sudden end to the conflict between Israel and the Palestinians nor an immediate American withdrawal from Iraq would change. The alternative to American predominance in the region is not balance and peace. It is further competition. The region and the states within it remain relatively weak. A diminution of American influence would not be followed by a diminution of other external influences. One could expect deeper involvement by both China and Russia, if only to secure their interests. 18 And one could also expect the more powerful states of the region, particularly Iran, to expand and fill the vacuum. It is doubtful that any American administration would voluntarily take actions that could shift the balance of power in the Middle East further toward Russia, China, or Iran. The world hasn 't changed that much. An American withdrawal from Iraq will not return things to "normal" or to a new kind of stability in the region. It will produce a new instability, one likely to draw the United States back in again. The alternative to American regional predominance in the Middle East and elsewhere is not a new regional stability. In an era of burgeoning nationalism, the future is likely to be one of intensified competition among nations and nationalist movements. Difficult as it may be to extend American predominance into the future, no one should imagine that a reduction of American power or a retraction of American influence and global involvement will provide an easier path.

Decreased launch costs will spur domestic commercial sector growth—

Collins and Autino, ‘9 -- Life & Environmental Science, Azabu University, Japan, and Andromeda Inc., Italy

[Patrick Collins\* & Adriano Autino\*\*, What the Growth of a Space Tourism Industry Could Contribute to Employment, Economic Growth, Environmental Protection, Education, Culture and World Peace,

Originally presented at Plenary Session of the International Academy of Astronautics' 1st Symposium on Private Human Access to Space, held at Arcachon in France, 25-28 May 2008. Revised and updated 11 June 2009, http://www.spacefuture.com/archive/what\_the\_growth\_of\_a\_space\_tourism\_industry\_could\_contribute\_to\_employment\_economic\_growth\_environmental\_protection\_education\_culture\_and\_world\_peace.shtml]

Reducing the cost of space travel to 1% of existing launch vehicles' costs, in combination with the growth of a new consumer service market in space, would greatly aid the growth of many commercial space activities, thereby creating numerous new business opportunities both on Earth and in space. This process is already at work on a small scale in relation to sub-orbital ﬂight services: in addition to a large number of travel companies acting as agents for sub-orbital ﬂights (including JTB, the largest travel company in Japan), Zero-G Corporation supplies parabolic ﬂight services, Bigelow Aerospace is developing the first space hotel, Spaceport Associates advises on spaceport design, Orbital Outfitters Inc. supplies customised ﬂight suits, spaceports are being developed in several places, and several support organisations have been established. All of this activity is occurring some years before the first high-priced services even start, so a much wider range of different space travel-related businesses are sure to grow in future. In the case of orbital services there will be an even wider range of companies with much larger revenues, including companies supplying various services to orbiting hotels. These will include services which terrestrial hotels typically purchase today, such as catering, cleaning, accounting, entertainment, plus such additional services as space-based window maintenance, air supply, solargenerated electricity, water supply, waste disposal services, and others. As activities in orbit expand progressively, they could grow to include use of materials extracted from the Moon and near-Earth asteroids and cometoids, of which the potential has been researched for several decades [11]. Due to the much higher cost of activities in orbit than on the surface of the Earth, orbiting hotels seem likely to create the first market for non-terrestrial materials like ice, water, oxygen and hydrogen, as discussed in [12].

Comp. Adv.—US Losing Competitiveness (Gen.)

China due to surpass US in space flight—this will crush US competitiveness

Fox News, 7/11/11, http://www.foxnews.com/scitech/2011/07/11/china-aiming-high-in-space-as-us-shuttle-program-winds-down/

While the United States is still working out its next move as the space shuttle program winds down, China is forging ahead. Some experts worry the U.S. could slip behind China in human spaceflight -- the realm of space science with the most prestige. "Space leadership is highly symbolic of national capabilities and international influence, and a decline in space leadership will be seen as symbolic of a relative decline in U.S. power and influence," said Scott Pace, an associate NASA administrator in the George W. Bush administration. He was a supporter of Bush's plan -- shelved by President Obama -- to return Americans to the moon.

The US lags behind Europe and other in the commercial space race—Only governmental intervention into the commercial sector will ensure US leadership

Gropman, ‘8

[Alan L. Gropman, Competitiveness, Innovation Lacking in The Space Industry, National Defense, December 2008, http://www.nationaldefensemagazine.org/archive/2008/December/Pages/Competitiveness,InnovationLackinginTheSpaceIndustry.aspx]

The nation’s space policy generally seeks to maintain U.S. leadership in technology, ensure self-defense and the exploitation of space for national security and economic prosperity. But there is still no cohesive or specific plan to invigorate the commercial space market. These and other challenges that confront the space industry — such as declining innovation and competitiveness — were the subject of a study by the Industrial College of the Armed Forces. One of the most significant policy issues that affect this industry are the export control rules, said the ICAF study. The International Traffic in Arms Regulations (ITAR) has been the source of ongoing debate among the State Department, Congress and the space industry. The State Department contends ITAR has had limited negative effects and has provided essential security benefits. Congress concedes there may be room for improvement but has consistently failed to act. U.S. companies view ITAR as a significant barrier that stifles trade and weakens the ability of domestic companies to compete in the global market. The government must re-examine current export control policies to seek a better balance between assuring national security and fostering an innovative space industrial base, the study said. Acquisition policies also are cause for concern. Poor acquisition decisions in past space programs have led to unrealistic cost forecasts and rampant requirements growth, said the ICAF study. Budget and schedule overruns in strategic military space programs continue to generate high political and financial costs. The space industry today evidences little innovation, little competition, low capacity and high costs. As U.S. reliance on space continues to increase, these industry conditions become growing concerns, the study said. Why haven’t newer technologies emerged in the last 40 years? Until new technologies are developed, which is not likely to occur without increased investment by government, the current decline will continue. The Chinese test of a direct-ascent, kinetic kill anti-satellite weapon in 2007 raised legal, ethical and policy questions regarding the “weaponization” of space. This test forces the United States to confront the possibility of a challenge to its use of space. The 2006 U.S. space policy announces the government will take “actions necessary to protect its space capabilities; respond to interference; and deny, if necessary, adversaries the use of space capabilities hostile to national interests.” Since the potential for such attacks is manifest, senior leadership must address the scope of a national response. The number of space-faring nations is rising because space is a fertile ground for economic development, international cooperation or perhaps conflict. Global space governance, therefore, is essential to prevent national conflicts from extending to space. With increased space use and exploration, a number of related challenges remain unsolved, such as the need to address space-based property rights, ownership and mining rights or non-earth colonies. U.S. policy calls on the government to pursue international cooperation, but it fails to address strategic goals for space relations with such countries which have the potential to rival U.S. space capabilities. The nation’s success in space is dependent on government involvement, motivation and inspiration. The consolidation of the major industry players and a general downturn in the commercial market demand, combined with export restrictions, has left the United States space industry overly reliant on the government for revenue and technology development. Europeans are outdoing the United States in assisting this industry. The European Space Agency has focused exclusively on civil space. The new European space policy includes important provisions suggesting a potential for a larger economic and political role for space in Europe. The European Union is also providing an economic stimulus by funding research programs.

US space leadership threatened now

Kaufman, ‘8

[Mark Kaufman, US Finding Its Getting Crowded Out there, Washinton Post, 7/9/08, http://www.globalpolicy.org/component/content/article/152/25824.html]

Although the United States remains dominant in most space-related fields -- and owns half the military satellites currently orbiting Earth -- experts say the nation's superiority is diminishing, and many other nations are expanding their civilian and commercial space capabilities at a far faster pace. "We spent many tens of billions of dollars during the Apollo era to purchase a commanding lead in space over all nations on Earth," said NASA Administrator Michael D. Griffin, who said his agency's budget is down by 20 percent in inflation-adjusted terms since 1992. "We've been living off the fruit of that purchase for 40 years and have not . . . chosen to invest at a level that would preserve that commanding lead." In a recent in-depth study of international space competitiveness, the technology consulting firm Futron of Bethesda found that the globalizing of space is unfolding more broadly and quickly than most Americans realize. "Systemic and competitive forces threaten U.S. space leadership," company president Joseph Fuller Jr. concluded. Six separate nations and the European Space Agency are now capable of sending sophisticated satellites and spacecraft into orbit -- and more are on the way. New rockets, satellites and spacecraft are being planned to carry Chinese, Russian, European and Indian astronauts to the moon, to turn Israel into a center for launching minuscule "nanosatellites," and to allow Japan and the Europeans to explore the solar system and beyond with unmanned probes as sophisticated as NASA's.

US losing in the commercial launch market

Hertzfeld and Peter, ‘7 –Space Policy Institute

[Henry R. Hertzfeld, , and Nicolas Peter Space Policy Institute, George Washington University, “Developing new launch vehicle technology: The case for multi-national private sector cooperation,”

Space Policy 23 (2007) 81–89, p. 82]

This changing context of the launching sector has led not only to a declining influence of US vehicles in the political context, but also to a major decline in the USA’s share of the global commercial launch market. Vehicles from Russia and Europe offer cheaper prices than and equal reliability and capability as US vehicles, although factoring in a true comparison is difficult because of exchange rate issues and lingering elements of non-market cultural and financial factors.

Comp. Adv. – AT: Market Will Rebound in Squo

There won’t be a market rebound in the status quo

Futron ‘5 [Futron Corporation, Technology management consulting firm. Futron applies analytically rigorous decision-support methods to transform data into information.The Declining U.S. Role in the Commercial Launch Industry, June 2005, p. 5-6]

These current problems with the commercial launch industry in general, and the U.S. industry in particular, would be less of a concern if the market bounced back to levels approaching the boom of the late 1990s. However, while there are some signs of resuscitation of the industry from its current trough, there is little evidence to indicate that the commercial launch market will return to those robust levels of activity in the foreseeable future.

Comp. Adv. – Comp. Key to Heg

Space leadership is critical to overall US hegemony- provides intelligence and warfighting capabilities.

Young, ‘8 [Thomas, Chair for the Institute for Defense Analyses Research Group, “Leadership, Management, and Organization for National Security Space”. July 2008. [http://www.armyspace.army.mil/ASJ/Images/National\_Security\_S pace\_Study\_Final\_Sept\_16.pdf](http://www.armyspace.army.mil/ASJ/Images/National_Security_Space_Study_Final_Sept_16.pdf)]

Today, U.S. leadership in space provides a vital national advantage across the scientific, commercial, and national security realms. In particular, space is of critical importance to our national intelligence and warfighting capabilities. The panel members nevertheless are unanimous in our conviction that, without significant improvements in the leadership and management of NSS programs, U.S. space preeminence will erode to the extent that space ceases to provide a competitive national security advantage. Space technology is rapidly proliferating across the globe, and many of our most important capabilities and successes were developed and fielded with a government technical workforce and a management structure that no longer exist. *U.S. Leadership in Space is a Vital National Advantage* Space capabilities underpin U.S. economic, scientific, and military leadership. The space enterprise is embedded in the fabric of our nation’s economy, providing technological leadership and sustainment of the industrial base. To cite but one example, the Global Positioning System (GPS) is the world standard for precision navigation and timing. Global awareness provided from space provides the ability to effectively plan for and respond to such critical national security requirements as intelligence on the military capabilities of potential adversaries, intelligence on Weapons of Mass Destruction (WMD) program proliferation, homeland security, and missile warning and defense. Military strategy, operations, and tactics are predicated upon the availability of space capabilities.

Space competitiveness key to hegemony

Snead, ‘7 [Mike Snead, “6 - Why the next president should start America on the path to becoming a true spacefaring nation,” SpaceFaring America Weblog, 6/3/07, http://spacefaringamerica.net/2007/06/03/6--why-the-next-president-should-start-america-on-the-path-to-becoming-a-true-spacefaring-nation.aspx]

Great power status is achieved through competition between nations. This competition is often based on advancing science and technology and applying these advancements to enabling new operational capabilities. A great power that succeeds in this competition adds to its power while a great power that does not compete or does so ineffectively or by choice, becomes comparatively less powerful. Eventually, it loses the great power status and then must align itself with another great power for protection. As the pace of science and technology advancement has increased, so has the potential for the pace of change of great power status. While the U.S. "invented" powered flight in 1903, a decade later leadership in this area had shifted to Europe. Within a little more than a decade after the Wright Brothers' first flights, the great powers of Europe were introducing aeronautics into major land warfare through the creation of air forces. When the U.S. entered the war in 1917, it was forced to rely on French-built aircraft. Twenty years later, as the European great powers were on the verge of beginning another major European war, the U.S. found itself in a similar situation where its choice to diminish national investment in aeronautics during the 1920's and 1930's—you may recall that this was the era of General Billy Mitchell and his famous efforts to promote military air power—placed U.S. air forces at a significant disadvantage compared to those of Germany and Japan. This was crucial because military air power was quickly emerging as the "game changer" for conventional warfare. Land and sea forces increasingly needed capable air forces to survive and generally needed air superiority to prevail. With the great power advantages of becoming spacefaring expected to be comparable to those derived from becoming air-faring in the 1920's and 1930's, a delay by the U.S. in enhancing its great power strengths through expanded national space power may result in a reoccurrence of the rapid emergence of new or the rapid growth of current great powers to the point that they are capable of effectively challenging the U.S. Many great powers—China, India, and Russia—are already speaking of plans for developing spacefaring capabilities. Yet, today, the U.S. retains a commanding aerospace technological lead over these nations. A strong effort by the U.S. to become a true spacefaring nation, starting in 2009 with the new presidential administration, may yield a generation or longer lead in space, not just through prudent increases in military strength but also through the other areas of great power competition discussed above. This is an advantage that the next presidential administration should exercise.

Competitiveness is the key internal link to hegemony-the U.S. is falling behind in innovation and research

Dabney, 2010 [Michael, a former bioscience communicator at the University of California, San Diego, is a freelance writer based in Chula Vista, Calif., specializing in science and education; The Epoch Times, 15 August, U.S. Competitive Edge in Jeopardy, LexisNexis]

In his seminal 2002 best-seller “The Creative Class,” author Richard Florida had a thing or two to say about America’s diminishing leadership in innovation. He wrote: “The United States appears to have thrown its gearshift into reverse. At all levels of government and even in the private sector, Americans have been cutting back crucial investments in creativity—in education, in research, in arts and culture—while pouring billions into low-return or no-return public projects like sports stadiums … If these trends continue, the U.S. may well squander its once-considerable lead.” It is America’s declining hegemony in high-tech innovation and research that has got decision makers in the U.S.—from the Oval Office and the National Science Foundation in Washington to researchers, business leaders, and educators across the country—concerned. “For more than half a century, the United States has led the world in scientific discovery and innovation. It has been a beacon, drawing the best scientists to its educational institutions, industries and laboratories from around the globe,” The Task Force on the Future of American Innovation wrote in the report “The Knowledge Economy: Is the United States Losing Its Competitive Edge?” “However, in today’s rapidly evolving competitive world, the United States can no longer take its supremacy for granted. Nations from Europe to Eastern Asia are on a fast track to pass the United States in scientific excellence and technological innovation,” the report said. Indeed, there are warnings on the horizon. Here are just some of them: Fewer graduates in science and engineering: America’s educational system was once at the forefront of producing the best scientists and engineers; but today, undergraduate science and engineering degrees in the United States are being awarded less frequently than in other countries. For example, according to the Council on Competitiveness, the ratio of first university degrees in natural sciences and engineering to the college-age population in the United States is only 5.7 degrees per 100. Some European countries, including Spain, Ireland, Sweden, the United Kingdom, France, and Finland, award between 8 and 13 degrees per 100. Japan awards 8 per 100, and Taiwan and South Korea each award about 11 per 100. Stagnant growth: Although the United States remains a competitive leader in innovation, it has made the least progress of all developing nations in competiveness and innovation capacity over the last decade, according to a 2009 report by the Information Technology and Innovation Foundation titled “The Atlantic Century: Benchmarking EU & U.S. Innovation and Competitiveness.” A fall from grace in key high-tech sectors: From 1998 to 2003, the balance of trade in the manufacture of aircraft—which for years was one of the strongest U.S. export sectors—fell from $39 billion to $24 billion, a loss of $15 billion, reflecting increased sales of foreign-made commercial aircraft to U.S. carriers. In areas of information technology, biotechnology, nanotechnology, and fusion energy science, the United States is also losing ground to Asia and some countries in the European Union (EU). “‘Can America compete?’ is the nation’s new No. 1 anxiety, the topic of emotional debate,” wrote Fortune magazine’s Geoffrey Colvin. “We’re not building human capital the way we used to. Our primary and secondary schools are falling behind the rest of the world’s. Our universities are still excellent, but the foreign students who come to them are increasingly taking their educations back home. As other nations multiply their science and engineering graduates—building the foundation for economic progress—ours are declining, in part because those fields are seen as nerdish and simply uncool.” To be sure, experts are quick to point out that despite these challenges, no one is saying that Americans can’t adapt and get back on track. The Task Force on the Future of American Innovation report stated: “The United States still leads the world in research and discovery, but our advantage is rapidly eroding, and our global competitors may soon overtake us.” To remain competitive in the global arena, the task force said, the United States must redirect its attention to the factors that have driven American innovation for years: research (especially that which is funded through federal and private entities for science and engineering), education, the technical workforce, and economic growth. Columbia University professor Dr. Jeffrey Sachs, cited in Colvin’s article, underscores this point. In a competitive global market, he said, it is science and technological breakthroughs that fundamentally influence economic development, and in an economy where technology leadership determines the winners, education trumps everything. That’s a problem for America, Bill Gates told Fortune magazine. He said while American fourth-graders are among the world’s best in math and science, by ninth grade they’ve fallen way behind. "This isn’t an accident or a flaw in the system; it is the system,” said Gates. That is why America’s decline in producing top-notch scientists and engineers is such a serious concern, experts say. While America lags, “low-cost countries—not just China and India but also Mexico, Malaysia, Brazil, and others—are turning out large numbers of well-educated young people fully qualified to work in an information-based economy,” said Colvin. For example, he said, China in 2005 produced about 3.3 million college graduates, India 3.1 million (the majority of them English-speaking), and the United States just 1.3 million. In engineering, China’s graduates numbered over 600,000, India’s 350,000 and the United States’ only about 70,000, making it highly probable that the United States may be required to outsource its research and development overseas eventually if this trend is not addressed. “Americans who thought outsourcing only threatened factory workers and call-center operators are about to learn otherwise,” Colvin warned. While many studies exploring the competitiveness of America in science and technology indicate that America still leads other countries in key areas of these fields, the 2009 report from the Information Technology and Innovation Foundation found cause for both the United States and the EU to be concerned in the face of increasing Asian competition. The report evaluated and rated global innovation-based competitiveness in science and technology of 40 nations and regions (including the EU-10 and the EU-15) as they currently stand, and in terms of the progress they have made over the last decade. In it, the United States was rated fourth place in global competitiveness among all nations, and the EU 18th place. However, the study found that the United States has made the least progress of the 40 nations and regions in improvement in international competitiveness and innovation capacity over the last decade, while China was rated first in this category. The EU-15 region was found to have made more improvements over the last decade than the United States but slower than the overall average and, as a result, was ranked 29th among the 40 nations and regions. “If the EU-15 region as a whole continues to improve at this faster rate than the United States, it would surpass the United States in innovation-based competitiveness by 2020,” the report said. However, with the positive showing of Asian nations in the study, the report’s authors Robert Atkinson and Scott Andes wrote, “To find global leaders [in high tech], Asia is the place to look.” The study’s findings also have significant implications for Europe and the United States, the authors said. First, the rise of global economic competition means that the United States and Europe need to think of themselves as a big state or a big nation, and proactively put in place national or continental economic development strategies.

Comp. Adv – Heg Good- Lashout

Heg decline causes US lash-out

Goldstein, 2007

(Avery, Professor of Global Politics and International Relations @ University of Pennsylvania, “Power transitions, institutions, and China's rise in East Asia: Theoretical expectations and evidence,” Journal of Strategic Studies, Volume 30, Issue 4 & 5 August)

Two closely related, though distinct, theoretical arguments focus explicitly on the consequences for international politics of a shift in power between a dominant state and a rising power. In War and Change in World Politics, Robert Gilpin suggested that peace prevails when a dominant state’s capabilities enable it to ‘govern’ an international order that it has shaped. Over time, however, as economic and technological diffusion proceeds during eras of peace and development, other states are empowered. Moreover, the burdens of international governance drain and distract the reigning hegemon, and challengers eventually emerge who seek to rewrite the rules of governance. As the power advantage of the erstwhile hegemon ebbs, it may become desperate enough to resort to the ultima ratio of international politics, force, to forestall the increasingly urgent demands of a rising challenger. Or as the power of the challenger rises, it may be tempted to press its case with threats to use force. It is the rise and fall of the great powers that creates the circumstances under which major wars, what Gilpin labels ‘hegemonic wars’, break out.13 Gilpin’s argument logically encourages pessimism about the implications of a rising China. It leads to the expectation that international trade, investment, and technology transfer will result in a steady diffusion of American economic power, benefiting the rapidly developing states of the world, including China. As the US simultaneously scurries to put out the many brushfires that threaten its far-flung global interests (i.e., the classic problem of overextension), it will be unable to devote sufficient resources to maintain or restore its former advantage over emerging competitors like China. While the erosion of the once clear American advantage plays itself out, the US will find it ever more difficult to preserve the order in Asia that it created during its era of preponderance. The expectation is an increase in the likelihood for the use of force – either by a Chinese challenger able to field a stronger military in support of its demands for greater influence over international arrangements in Asia, or by a besieged American hegemon desperate to head off further decline. Among the trends that alarm those who would look at Asia through the lens of Gilpin’s theory are China’s expanding share of world trade and wealth (much of it resulting from the gains made possible by the international economic order a dominant US established); its acquisition of technology in key sectors that have both civilian and military applications (e.g., information, communications, and electronics linked with the ‘revolution in military affairs’); and an expanding military burden for the US (as it copes with the challenges of its global war on terrorism and especially its struggle in Iraq) that limits the resources it can devote to preserving its interests in East Asia.14 Although similar to Gilpin’s work insofar as it emphasizes the importance of shifts in the capabilities of a dominant state and a rising challenger, the power-transition theory A. F. K. Organski and Jacek Kugler present in The War Ledger focuses more closely on the allegedly dangerous phenomenon of ‘crossover’– the point at which a dissatisfied challenger is about to overtake the established leading state.15 In such cases, when the power gap narrows, the dominant state becomes increasingly desperate to forestall, and the challenger becomes increasingly determined to realize the transition to a new international order whose contours it will define. Though suggesting why a rising China may ultimately present grave dangers for international peace when its capabilities make it a peer competitor of America, Organski and Kugler’s power-transition theory is less clear about the dangers while a potential challenger still lags far behind and faces a difficult struggle to catch up. This clarification is important in thinking about the theory’s relevance to interpreting China’s rise because a broad consensus prevails among analysts that Chinese military capabilities are at a minimum two decades from putting it in a league with the US in Asia.16 Their theory, then, points with alarm to trends in China’s growing wealth and power relative to the United States, but especially looks ahead to what it sees as the period of maximum danger – that time when a dissatisfied China could be in a position to overtake the US on dimensions believed crucial for assessing power. Reports beginning in the mid-1990s that offered extrapolations suggesting China’s growth would give it the world’s largest gross domestic product (GDP aggregate, not per capita) sometime in the first few decades of the twentieth century fed these sorts of concerns about a potentially dangerous challenge to American leadership in Asia.17 The huge gap between Chinese and American military capabilities (especially in terms of technological sophistication) has so far discouraged prediction of comparably disquieting trends on this dimension, but inklings of similar concerns may be reflected in occasionally alarmist reports about purchases of advanced Russian air and naval equipment, as well as concern that Chinese espionage may have undermined the American advantage in nuclear and missile technology, and speculation about the potential military purposes of China’s manned space program.18 Moreover, because a dominant state may react to the prospect of a crossover and believe that it is wiser to embrace the logic of preventive war and act early to delay a transition while the task is more manageable, Organski and Kugler’s powertransition theory also provides grounds for concern about the period prior to the possible crossover.19

Comp. Adv. – Heg Sustainable

Hegemony is sustainable and solves global war – there is no alternative

Knowles, ‘ 9 - Assistant Professor – New York University School of Law

Robert Knowles (Assistant Professor – New York University School of Law) 2009 “american hegemony and the foreign affairs constitution” Arizona State Law Journal, Vol. 41 Lexis

First, the "hybrid" hegemonic model assumes that the goal of U.S. foreign affairs should be the preservation of American hegemony, which is more stable, more peaceful, and better for America's security and prosperity, than the alternatives. If the United States were to withdraw from its global leadership role, no other nation would be capable of taking its place. 378 The result would be radical instability and a greater risk of major war. 379 In addition, the United States would no longer benefit from the public goods it had formerly produced; as the largest consumer, it would suffer the most. Second, the hegemonic model assumes that American hegemony is unusually stable and durable. 380 As noted above, other nations have many incentives to continue to tolerate the current order. 381 And although other nations or groups of nations - China, the European Union, and India are often mentioned - may eventually overtake the United States in certain areas, such as manufacturing, the U.S. will remain dominant in most measures of capability for decades. According to 2007 estimates, the U.S. economy was projected to be twice the size of China's in 2025. 382 The U.S. accounted for half of the world's military spending in 2007 and holds enormous advantages in defense technology that far outstrip would-be competitors. 383 Predictions of American decline are not new, and they have thus far proved premature. 384

The US can continue its dominance well into the future

Thayer, 07 – Associate Professor in the Department of Defense and Strategic Studies, Missouri State University

(Bradley A., American Empire, Routledge, page 12)

The United States has the ability to dominate the world because it has prodi-gious military capability, economic might, and soft power. The United States dominates the world today, but will it be able to do so in the future? The answer is yes, for the foreseeable future—the next thirty to forty years.17 Indeed, it may exist for much longer. I would not be surprised to see American dominance last much longer and, indeed, anticipate that it will. But there is simply too much uncertainty about events far in the future to make reliable predictions. In this section of the chapter, I explain why the United States has the abil-ity to dominate the world for the predictable future, if it has the will to do so. There are two critical questions that serve as the foundation for this debate: “Can America dominate international politics?” and “Should America domi-nate international politics?”

Heg sustainable – multiple reasons

Kagan, 07 – Senior Associate at the Carnegie Endowment for International Peace and Senior Transatlantic Fellow at the German Marshall Fund (Robert, “End of Dreams, Return of History,” Hoover Institution, No. 144, August/September, http://www.hoover.org/publications/policy-review/article/6136)

These American traditions, together with historical events beyond Americans’ control, have catapulted the United States to a position of pre-eminence in the world. Since the end of the Cold War and the emergence of this “unipolar” world, there has been much anticipation of the end of unipolarity and the rise of a multipolar world in which the United States is no longer the predominant power. Not only realist theorists but others both inside and outside the United States have long argued the theoretical and practical unsustainability, not to mention undesirability, of a world with only one superpower. Mainstream realist theory has assumed that other powers must inevitably band together to balance against the superpower. Others expected the post-Cold War era to be characterized by the primacy of geoeconomics over geopolitics and foresaw a multipolar world with the economic giants of Europe, India, Japan, and China rivaling the United States. Finally, in the wake of the Iraq War and with hostility to the United States, as measured in public opinion polls, apparently at an all-time high, there has been a widespread assumption that the American position in the world must finally be eroding. Yet American predominance in the main categories of power persists as a key feature of the international system. The enormous and productive American economy remains at the center of the international economic system. American democratic principles are shared by over a hundred nations. The American military is not only the largest but the only one capable of projecting force into distant theaters. Chinese strategists, who spend a great deal of time thinking about these things, see the world not as multipolar but as characterized by “one superpower, many great powers,” and this configuration seems likely to persist into the future absent either a catastrophic blow to American power or a decision by the United States to diminish its power and international influence voluntarily. 11

Comp. Adv. – High Launch Costs Prevent

High costs prevent commercialization and exploration

Foust, ‘4

[Jeff Foust, Reducing Launch Costs: A Lower Limit, The Space Review, 9/27/04, http://www.thespacereview.com/article/233/1]

A central tenet of the faith held by advocates, entrepreneurs, and others in an expanded presence in space is that launch costs must, and can, come down. These people will often debate endlessly the means for lowering these costs—reusable launch vehicles, big dumb boosters, or exotic technologies like a space elevator—and even what the magic price point is: $1,000, $500, or $100 a pound, and sometimes lower. However, all will agree that launch costs today are far too high to permit the commercialization and exploration of space they all desire.

Growth of the commercial market is dependent on lower launch costs

Money, ’11—M.A. in Science, Tech and Public Policy from George Washington

[Stewart Money, M.A. in Science, Technology and Public Policy from The George Washington University. He lives in Alabama and rides a horse named Apollo, Taking the initiative: SLI and the next generation, The Space Review, 2/21/11, http://www.thespacereview.com/article/1784/1]

Whether or not such a new era materializes, and to what extent, will be determined by many factors, but it seems clear that the scope and resilience of the market will be determined by launch costs. SpaceX is currently the runaway price leader with a price of no more than $56 million per flight for a commercial Falcon 9. While this figure represents definitive—even amazing—progress in reducing costs, it may also represent a floor. The price of space launch is still exorbitantly expensive, and incorporating the costs of achieving commercial crew promises to make it even more so. It remains to be seen whether higher flight rates can offset the upward pressure sufficiently to even maintain the current baseline. Consequently, without much deeper price reductions, which can only come from some form of reusability, an expanded commercial market in low Earth orbit remains very much in question. Seemingly, only SpaceX founder Elon Musk embraces the challenge, observing that if his company does not achieve reusability, “we will consider ourselves to have failed.”

Rising launch costs limit growth of the commercial space sector

Collins, ’92 –Imperial College Director of Undergraduate Studies

[Patrick Collins, Director of Undergraduate Studies, Imperial College, London University, Implications of Reduced Launch Costs for Commercial Space Law, Space Future, 1992, http://www.spacefuture.com/archive/implications\_of\_reduced\_launch\_cost\_for\_commercial\_space\_law.shtml]

The very limited scope of commercial space activities to date has been due primarily to the very high cost of launch. The rate of growth of commercial space activities in future will depend critically on how fast and how far launch costs fall. In normal commercial situations, costs fall progressively over an extended period. However, the evolution of the space industry to date has been very different from the evolution of other new industries, due to the strategic role played by launch vehicle technology during the "Cold War". In particular, all launch vehicles were developed by government agencies, and most had military requirements as a major design driver. Non-military European and Japanese launch vehicles were also developed by government agencies, with the aim of catching up with US technology. As a result of this situation, the costs of launch in the Western nations have not fallen significantly over the past twenty-five years. (Soviet launch costs fell during this period through the production of many hundreds of units of a standard launch vehicle, but the scope for launch cost reduction using expendable vehicles is strictly limited.)

Reducing launch costs produces cheaper space hardware

Collins, ’92 –Imperial College Director of Undergraduate Studies

[Patrick Collins, Director of Undergraduate Studies, Imperial College, London University, Implications of Reduced Launch Costs for Commercial Space Law, Space Future, 1992, http://www.spacefuture.com/archive/implications\_of\_reduced\_launch\_cost\_for\_commercial\_space\_law.shtml]

An important, but not widely recognised effect of reducing launch costs is that the production costs of space hardware will also fall more or less proportionately. This is for several reasons, but primarily because space will become accessible, and so spacecraft will be able to be maintained and repaired in orbit. As a result the cost of much space hardware will reach approximately the level of hardware built for other extreme but accessible environments, such as underwater, which are typically 1% of space industry costs (7).

Comp. Adv.—Plan Solves Comp

New launch systems increase competitiveness

Coopersmith, ’10 – Texas A&M Tech Historian

Jonathan Coopersmith, Obama in space: bold but not bold enough, 4/12/10, http://www.thespacereview.com/article/1603/1

Developing a ground-based system should give the United States a competitive edge against foreign rocket providers. Currently, American launch services are more expensive than their foreign counterparts, a consequence of their lower costs and, in the case of Ariane, better geography. A ground-launched system could change the competitive dynamics of launching.

\*\*\*\*NASA Climate Advantage\*\*\*\*

1AC NASA Climate Monitoring Advantage

Warming is real and human induced – consensus is on our side – numerous studies prove

Rahmstorf 8 – Professor of Physics of the Oceans [Richard Rahmstorf, of Physics of the Oceans at Potsdam University, Global Warming: Looking Beyond Kyoto, Edited by Ernesto Zedillo, “Anthropogenic Climate Change?,” pg. 42-4]

It is time to turn to statement B: human activities are altering the climate. This can be broken into two parts. The first is as follows: global climate is warming. This is by now a generally undisputed point (except by novelist Michael Crichton), so we deal with it only briefly. The two leading compilations of data measured with thermometers are shown in figure 3-3, that of the National Aeronautics and Space Administration (NASA) and that of the British Hadley Centre for Climate Change. Although they differ in the details, due to the inclusion of different data sets and use of different spatial averaging and quality control procedures, they both show a consistent picture, with a global mean warming of 0.8°C since the late nineteenth century. Temperatures over the past ten years clearly were the warmest since measured records have been available. The year 1998 sticks out well above the longterm trend due to the occurrence of a major El Nino event that year (the last El Nino so far and one of the strongest on record). These events are examples of the largest natural climate variations on multiyear time scales and, by releasing heat from the ocean, generally cause positive anomalies in global mean temperature. It is remarkable that the year 2005 rivaled the heat of 1998 even though no El Nino event occurred that year. (A bizarre curiosity, perhaps worth mentioning, is that several prominent "climate skeptics" recently used the extreme year 1998 to claim in the media that global warming had ended. In Lindzen's words, "Indeed, the absence of any record breakers during the past seven years is statistical evidence that temperatures are not increasing.")33 In addition to the surface measurements, the more recent portion of the global warming trend (since 1979) is also documented by satellite data. It is not straightforward to derive a reliable surface temperature trend from satellites, as they measure radiation coming from throughout the atmosphere (not just near the surface), including the stratosphere, which has strongly cooled, and the records are not homogeneous' due to the short life span of individual satellites, the problem of orbital decay, observations at different times of day, and drifts in instrument calibration.' Current analyses of these satellite data show trends that are fully consistent with surface measurements and model simulations." If no reliable temperature measurements existed, could we be sure that the climate is warming? The "canaries in the coal mine" of climate change (as glaciologist Lonnie Thompson puts it) ~are mountain glaciers. We know, both from old photographs and from the position of the terminal moraines heaped up by the flowing ice, that mountain glaciers have been in retreat all over the world during the past century. There are precious few exceptions, and they are associated with a strong increase in precipitation or local cooling.36 I have inspected examples of shrinking glaciers myself in field trips to Switzerland, Norway, and New Zealand. As glaciers respond sensitively to temperature changes, data on the extent of glaciers have been used to reconstruct a history of Northern Hemisphere temperature over the past four centuries (see figure 3-4). Cores drilled in tropical glaciers show signs of recent melting that is unprecedented at least throughout the Holocene-the past 10,000 years. Another powerful sign of warming, visible clearly from satellites, is the shrinking Arctic sea ice cover (figure 3-5), which has declined 20 percent since satellite observations began in 1979. While climate clearly became warmer in the twentieth century, much discussion particularly in the popular media has focused on the question of how "unusual" this warming is in a longer-term context. While this is an interesting question, it has often been mixed incorrectly with the question of causation. Scientifically, how unusual recent warming is-say, compared to the past millennium-in itself contains little information about its cause. Even a highly unusual warming could have a natural cause (for example, an exceptional increase in solar activity). And even a warming within the bounds of past natural variations could have a predominantly anthropogenic cause. I come to the question of causation shortly, after briefly visiting the evidence for past natural climate variations. Records from the time before systematic temperature measurements were collected are based on "proxy data," coming from tree rings, ice cores, corals, and other sources. These proxy data are generally linked to local temperatures in some way, but they may be influenced by other parameters as well (for example, precipitation), they may have a seasonal bias (for example, the growth season for tree rings), and high-quality long records are difficult to obtain and therefore few in number and geographic coverage. Therefore, there is still substantial uncertainty in the evolution of past global or hemispheric temperatures. (Comparing only local or regional temperature; as in Europe, is of limited value for our purposes,' as regional variations can be much larger than global ones and can have many regional causes, unrelated to global-scale forcing and climate change.) The first quantitative reconstruction for the Northern Hemisphere temperature of the past millennium, including an error estimation, was presented by Mann, Bradley, and Hughes and rightly highlighted in the 2001 IPCC report as one of the major new findings since its 1995 report; it is shown in figure 3\_6.39 The analysis suggests that, despite the large error bars, twentieth-century warming is indeed highly unusual and probably was unprecedented during the past millennium. This result, presumably because of its symbolic power, has attracted much criticism, to some extent in scientific journals, but even more so in the popular media. The hockey stick-shaped curve became a symbol for the IPCC, .and criticizing this particular data analysis became an avenue for some to question the credibility of the IPCC. Three important things have been overlooked in much of the media coverage. First, even if the scientific critics had been right, this would not have called into question the very cautious conclusion drawn by the IPCC from the reconstruction by Mann, Bradley, and Hughes: "New analyses of proxy data for the Northern Hemisphere indicate that the increase in temperature in the twentieth century is likely to have been the largest of any century during the past 1,000 years." This conclusion has since been supported further by every single one of close to a dozen new reconstructions (two of which are shown in figure 3-6).Second, by far the most serious scientific criticism raised against Mann, Hughes, and Bradley was simply based on a mistake. 40 The prominent paper of von Storch and others, which claimed (based on a model test) that the method of Mann, Bradley, and Hughes systematically underestimated variability, "was [itself] based on incorrect implementation of the reconstruction procedure."41 With correct implementation, climate field reconstruction procedures such as the one used by Mann, Bradley, and Hughes have been shown to perform well in similar model tests. Third, whether their reconstruction is accurate or not has no bearing on policy. If their analysis underestimated past natural climate variability, this would certainly not argue for a smaller climate sensitivity and thus a lesser concern about the consequences of our emissions. Some have argued that, in contrast, it would point to a larger climate sensitivity. While this is a valid point in principle, it does not apply in practice to the climate sensitivity estimates discussed herein or to the range given by IPCC, since these did not use the reconstruction of Mann, Hughes, and Bradley or any other proxy records of the past millennium. Media claims that "a pillar of the Kyoto Protocol" had been called into question were therefore misinformed. As an aside, the protocol was agreed in 1997, before the reconstruction in question even existed. The overheated public debate on this topic has, at least, helped to attract more researchers and funding to this area of paleoclimatology; its methodology has advanced significantly, and a number of new reconstructions have been presented in recent years. While the science has moved forward, the first seminal reconstruction by Mann, Hughes, and Bradley has held up remarkably well, with its main features reproduced by more recent work. Further progress probably will require substantial amounts of new proxy data, rather than further refinement of the statistical techniques pioneered by Mann, Hughes, and Bradley. Developing these data sets will require time and substantial effort. It is time to address the final statement: most of the observed warming over the past fifty years is anthropogenic. A large number of studies exist that have taken different approaches to analyze this issue, which is generally called the "attribution problem." I do not discuss the exact share of the anthropogenic contribution (although this is an interesting question). By "most" I imply mean "more than 50 percent.”The first and crucial piece of evidence is, of course, that the magnitude of the warming is what is expected from the anthropogenic perturbation of the radiation balance, so anthropogenic forcing is able to explain all of the temperature rise. As discussed here, the rise in greenhouse gases alone corresponds to 2.6 W/tn2 of forcing. This by itself, after subtraction of the observed 0'.6 W/m2 of ocean heat uptake, would Cause 1.6°C of warming since preindustrial times for medium climate sensitivity (3"C). With a current "best guess'; aerosol forcing of 1 W/m2, the expected warming is O.8°c. The point here is not that it is possible to obtain the 'exact observed number-this is fortuitous because the amount of aerosol' forcing is still very' uncertain-but that the expected magnitude is roughly right. There can be little doubt that the anthropogenic forcing is large enough to explain most of the warming. Depending on aerosol forcing and climate sensitivity, it could explain a large fraction of the warming, or all of it, or even more warming than has been observed (leaving room for natural processes to counteract some of the warming). The second important piece of evidence is clear: there is no viable alternative explanation. In the scientific literature, no serious alternative hypothesis has been proposed to explain the observed global warming. Other possible causes, such as solar activity, volcanic activity, cosmic rays, or orbital cycles, are well observed, but they do not show trends capable of explaining the observed warming. Since 1978, solar irradiance has been measured directly from satellites and shows the well-known eleven-year solar cycle, but no trend. There are various estimates of solar variability before this time, based on sunspot numbers, solar cycle length, the geomagnetic AA index, neutron monitor data, and, carbon-14 data. These indicate that solar activity probably increased somewhat up to 1940. While there is disagreement about the variation in previous centuries, different authors agree that solar activity did not significantly increase during the last sixty-five years. Therefore, this cannot explain the warming, and neither can any of the other factors mentioned. Models driven by natural factors only, leaving the anthropogenic forcing aside, show a cooling in the second half of the twentieth century (for an example, See figure 2-2, panel a, in chapter 2 of this volume). The trend in the sum of natural forcings is downward.The only way out would be either some as yet undiscovered unknown forcing or a warming trend that arises by chance from an unforced internal variability in the climate system. The latter cannot be completely ruled out, but has to be considered highly unlikely. No evidence in the observed record, proxy data, or current models suggest that such internal variability could cause a sustained trend of global warming of the observed magnitude. As discussed, twentieth century warming is unprecedented over the past 1,000 years (or even 2,000 years, as the few longer reconstructions available now suggest), which does not 'support the idea of large internal fluctuations. Also, those past variations correlate well with past forcing (solar variability, volcanic activity) and thus appear to be largely forced rather than due to unforced internal variability." And indeed, it would be difficult for a large and sustained unforced variability to satisfy the fundamental physical law of energy conservation. Natural internal variability generally shifts heat around different parts of the climate system-for example, the large El Nino event of 1998, which warmed, the atmosphere by releasing heat stored in the ocean. This mechanism implies that the ocean heat content drops as the atmosphere warms. For past decades, as discussed, we observed the atmosphere warming and the ocean heat content increasing, which rules out heat release from the ocean as a cause of surface warming. The heat content of the whole climate system is increasing, and there is no plausible source of this heat other than the heat trapped by greenhouse gases. ' A completely different approach to attribution is to analyze the spatial patterns of climate change. This is done in so-called fingerprint studies, which associate particular patterns or "fingerprints" with different forcings. It is plausible that the pattern of a solar-forced climate change differs from the pattern of a change caused by greenhouse gases. For example, a characteristic of greenhouse gases is that heat is trapped closer to the Earth's surface and that, unlike solar variability, greenhouse gases tend to warm more in winter, and at night. Such studies have used different data sets and have been performed by different groups of researchers with different statistical methods. They consistently conclude that the observed spatial pattern of warming can only be explained by greenhouse gases.49 Overall, it has to be considered, highly likely' that the observed warming is indeed predominantly due to the human-caused increase in greenhouse gases. ' This paper discussed the evidence for the anthropogenic increase in atmospheric CO2 concentration and the effect of CO2 on climate, finding that this anthropogenic increase is proven beyond reasonable doubt and that a mass of evidence points to a CO2 effect on climate of 3C ± 1.59C global-warming for a doubling of concentration. (This is, the classic IPCC range; my personal assessment is that, in-the light of new studies since the IPCC Third Assessment Report, the uncertainty range can now be narrowed somewhat to 3°C ± 1.0C) This is based on consistent results from theory, models, and data analysis, and, even in the absence-of any computer models, the same result would still hold based on physics and on data from climate history alone. Considering the plethora of consistent evidence, the chance that these conclusions are wrong has to be considered minute. If the preceding is accepted, then it follows logically and incontrovertibly that a further increase in CO2 concentration will lead to further warming. The magnitude of our emissions depends on human behavior, but the climatic response to various emissions scenarios can be computed from the information presented here. The result is the famous range of future global temperature scenarios shown in figure 3\_6.50 Two additional steps are involved in these computations: the consideration of anthropogenic forcings other than CO2 (for example, other greenhouse gases and aerosols) and the computation of concentrations from the emissions. Other gases are not discussed here, although they are important to get quantitatively accurate results. CO2 is the largest and most important forcing. Concerning concentrations, the scenarios shown basically assume that ocean and biosphere take up a similar share of our emitted CO2 as in the past. This could turn out to be an optimistic assumption; some models indicate the possibility of a positive feedback, with the biosphere turning into a carbon source rather than a sink under growing climatic stress. It is clear that even in the more optimistic of the shown (non-mitigation) scenarios, global temperature would rise by 2-3°C above its preindustrial level by the end of this century. Even for a paleoclimatologist like myself, this is an extraordinarily high temperature, which is very likely unprecedented in at least the past 100,000 years. As far as the data show, we would have to go back about 3 million years, to the Pliocene, for comparable temperatures. The rate of this warming (which is important for the ability of ecosystems to cope) is also highly unusual and unprecedented probably for an even longer time. The last major global warming trend occurred when the last great Ice Age ended between 15,000 and 10,000 years ago: this was a warming of about 5°C over 5,000 years, that is, a rate of only 0.1 °C per century. 52 The expected magnitude and rate of planetary warming is highly likely to come with major risk and impacts in terms of sea level rise (Pliocene sea level was 25-35 meters higher than now due to smaller Greenland and Antarctic ice sheets), extreme events (for example, hurricane activity is expected to increase in a warmer climate), and ecosystem loss. The second part of this paper examined the evidence for the current warming of the planet and discussed what is known about its causes. This part showed that global warming is already a measured and-well-established fact, not a theory. Many different lines of evidence consistently show that most of the observed warming of the past fifty years was caused by human activity. Above all, this warming is exactly what would be expected given the anthropogenic rise in greenhouse gases, and no viable alternative explanation for this warming has been proposed in the scientific literature. Taken together., the very strong evidence accumulated from thousands of independent studies, has over the past decades convinced virtually every climatologist around the world (many of whom were initially quite skeptical, including myself) that anthropogenic global warming is a reality with which we need to deal.

Prefer our scientific assessments over single scientists or fringe theories

Alley 10 – Professor of Geoscience @ Penn State

Richard, Professor of Geoscience @ Penn State, authored over 200 refereed scientific papers, which are "highly cited" according to a prominent indexing service, erved with distinguished national and international teams on major scientific assessment bodies, 11-17-2010, “CLIMATE CHANGE SCIENCE; COMMITTEE: HOUSE SCIENCE AND TECHNOLOGY;

SUBCOMMITTEE: ENERGY AND ENVIRONMENT,” CQ Congressional Testimony, Lexis

Background on Climate Change and Global Warming. Scientific assessments such as those of the National Academy of Sciences of the United States (e.g., National Research Council, 1975; 1979; 2001; 2006; 2008; 2010a; 2010b), the U.S. Climate Change Science Program, and the Intergovernmental Panel on Climate Change have for decades consistently found with increasingly high scientific confidence that human activities are raising the concentration of CO2 and other greenhouse gases in the atmosphere, that this has a warming effect on the climate, that the climate is warming as expected, and that the changes so far are small compared to those projected if humans burn much of the fossil fuel on the planet. The basis for expecting and understanding warming from CO2 is the fundamental physics of how energy interacts with gases in the atmosphere. This knowledge has been available for over a century, was greatly refined by military research after World War II, and is directly confirmed by satellite measurements and other data (e.g., American Institute of Physics, 2008; Harries et al., 2001; Griggs and Harries, 2007). Although a great range of ideas can be found in scientific papers and in statements by individual scientists, the scientific assessments by bodies such as the National Academy of Sciences consider the full range of available information. The major results brought forward are based on multiple lines of evidence provided by different research groups with different funding sources, and have repeatedly been tested and confirmed. Removing the work of any scientist or small group of scientists would still leave a strong scientific basis for the main conclusions. Ice Changes. There exists increasingly strong evidence for widespread, ongoing reductions in the Earth's ice, including snow, river and lake ice, Arctic sea ice, permafrost and seasonally frozen ground, mountain glaciers, and the great ice sheets of Greenland and Antarctica. The trends from warming are modified by effects of changing precipitation and of natural variability, as I will discuss soon, so not all ice everywhere is always shrinking. Nonetheless, warming is important in the overall loss of ice, although changes in oceanic and atmospheric circulation in response to natural or human causes also have contributed and will continue to contribute to changes. The most recent assessment by the IPCC remains relevant (Lemke et al., 2007). Also see the assessment of the long climatic history of the Arctic by the U.S. Climate Change Science Program (CCSP, 2009), showing that in the past warming has led to shrinkage of Arctic ice including sea ice and the Greenland ice sheet, and that sufficiently large warming has removed them entirely.

Warming is an existential threat

Mazo 10 – PhD in Paleoclimatology from UCLA

Jeffrey Mazo, Managing Editor, Survival and Research Fellow for Environmental Security and Science Policy at the International Institute for Strategic Studies in London, 3-2010, “Climate Conflict: How global warming threatens security and what to do about it,” pg. 122

The best estimates for global warming to the end of the century range from 2.5-4.~C above pre-industrial levels, depending on the scenario. Even in the best-case scenario, the low end of the likely range is 1.goC, and in the worst 'business as usual' projections, which actual emissions have been matching, the range of likely warming runs from 3.1--7.1°C. Even keeping emissions at constant 2000 levels (which have already been exceeded), global temperature would still be expected to reach 1.2°C (O'9""1.5°C)above pre-industrial levels by the end of the century." Without early and severe reductions in emissions, the effects of climate change in the second half of the twenty-first century are likely to be catastrophic for the stability and security of countries in the developing world - not to mention the associated human tragedy. Climate change could even undermine the strength and stability of emerging and advanced economies, beyond the knock-on effects on security of widespread state failure and collapse in developing countries.' And although they have been condemned as melodramatic and alarmist, many informed observers believe that unmitigated climate change beyond the end of the century could pose an existential threat to civilisation." What is certain is that there is no precedent in human experience for such rapid change or such climatic conditions, and even in the best case adaptation to these extremes would mean profound social, cultural and political changes.

Unfortunately, high launch costs prohibit NASA from doing necessary climate research

Clark, ‘11 [Stephen Clark, Rising launch costs could curtail NASA science missions,” Space Flight Now, 4/4/11, http://spaceflightnow.com/news/n1104/04launchcosts/]

Already faced with a potentially flat budget over the next half-decade, scientists and managers overseeing NASA's robotic science probes worry rising and volatile rocket launch prices could further limit the agency's ability to explore the solar system and maintain crucial climate research. Rising launch costs could claim a larger slice of a mission's budget, increasing the price of projects geared for planetary science, astrophysics and Earth observations, according to senior NASA officials. With the federal government's spotlight on spending cuts, it isn't likely NASA will get a budget boost to offset the launch costs, which experts say are triggered by inefficient rocket buying practices, an eroding commercial market, and uncertainty about the future of the space program. That leaves NASA with just one option: fly fewer missions. NASA uses a fleet of launch vehicles to deploy satellites. The agency often selects the United Launch Alliance Atlas 5 booster to launch solar system missions and large climate research spacecraft.

Climate regulations are inevitable—the question now is how to find the best solutions

Aggarwal and Dow, ’11 –Int’l Business and Finance Prof., and Int’l Finance Prof. [Raj Aggarwal, is the Sullivan Professor of International Business and Finance and the former Dean of the College of Business Administration at the University of Akron. and Sandra Dow, is a Professor of International Finance at the Monterey Institute of International Studies, a Graduate School of Middlebury College. Navigating the C² Economy: The 21st century business challenge, The European Financial Review, 4/15/11, http://www.europeanfinancialreview.com/?p=2876]

Regulation is inevitable. Many national, state, and local governments in the U.S. are rapidly introducing regulations and other mechanisms to reduce carbon footprints. While cap-and-trade markets currently provide a floor price for emissions abatement, corporate actions to mitigate climate change effects will probably increase in cost the longer they are delayed. Thus, it is likely to be useful to take some mitigation actions in anticipation of regulatory requirements. Moreover, many U.S. firms have begun to realize that their operations may be, directly or indirectly, affected by international regulations. Airlines fall into this category but there are other sectors where international regulation might not initially seem all that significant. Office Depot recognizes regulatory fallout from such indirect exposure: customers and suppliers who fall under international regulatory regimes will indirectly affect their business operations. More stringent regulation of carbon emissions seems inevitable and the uncertainty of the time horizon for this regulatory risk presents firms with a very challenging regulatory climate.

Climate monitoring will lead to the best warming solutions

Norris, ’10 – Chairman of the RAeS Space Group [Pat Norris, Watching Earth from Space: How Surveillance Helps Us - And Harms Us, August 2010, p. 46]

It would be nice if we could monitor which countries or regions are pumping carbon dioxide into the air. We could then fix quotas for each country or region and use fines or other inducements to ensure compliance. However, carbon dioxide is present in the air naturally and is not easily measured on a country-wide or regional scale. Scientists have had to work out how carbon dioxide and global warming affect the world, and try to monitor each of the effects - sea level rise, temperature rise, retreat of glaciers, melting of arctic ice, etc. Other chemicals resulting from human activity contribute to global warming such as methane from decay of man-made waste and from animal farming - discussed further below. Carbon dioxide was the first man-made chemical to be recognized as having major climate consequences, but global warming is affected by humans in many different ways. In order to decide what action is needed and then to check that those actions are working, we need to take good measurements of the earth's environment all the time. Each of the possible effects of global warming needs to be measured - everywhere. The scale of the task is daunting. We have to keep reminding ourselves that "nature doesn't do bail-outs" and press on with trying to monitor what is happening and then take remedial action.

NASA Adv. – GW Real, Human Induced, Cuts Key

Warming is real and human induced – drastic emissions reductions are key to avoid dangerous climate disruptions -now is key

-AR4 = IPCC

Somerville 11 – Professor of Oceanography @ UCSD [Richard Somerville, Distinguished Professor Emeritus and Research Professor at Scripps Institution of Oceanography at the University of California, San Diego, Coordinating Lead Author in Working Group I for the 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 3-8-2011, “CLIMATE SCIENCE AND EPA'S GREENHOUSE GAS REGULATIONS,” CQ Congressional Testimony, Lexis]

In early 2007, at the time of the publication of WG1 of AR4, the mainstream global community of climate scientists already understood from the most recent research that the latest observations of climate change were disquieting. In the words of a research paper published at the same time as the release of AR4 WG1, a paper for which I am a co-author, "observational data underscore the concerns about global climate change. Previous projections, as summarized by IPCC, have not exaggerated but may in some respects even have underestimated the change" (Rahmstorf et al. 2007). Now, in 2011, more recent research and newer observations have demonstrated that climate change continues to occur, and in several aspects the magnitude and rapidity of observed changes frequently exceed the estimates of earlier projections, including those of AR4. In addition, the case for attributing much observed recent climate change to human activities is even stronger now than at the time of AR4. Several recent examples, drawn from many aspects of climate science, but especially emphasizing atmospheric phenomena, support this conclusion. These include temperature, atmospheric moisture content, precipitation, and other aspects of the hydrological cycle. Motivated by the rapid progress in research, a recent scientific synthesis, The Copenhagen Diagnosis (Allison et al. 2009), has assessed recent climate research findings, including: -- Measurements show that the Greenland and Antarctic ice-sheets are losing mass and contributing to sea level rise. -- Arctic sea-ice has melted far beyond the expectations of climate models. -- Global sea level rise may attain or exceed 1 meter by 2100, with a rise of up to 2 meters considered possible. -- In 2008, global carbon dioxide emissions from fossil fuels were about 40% higher than those in 1990. -- At today's global emissions rates, if these rates were to be sustained unchanged, after only about 20 more years, the world will no longer have a reasonable chance of limiting warming to less than 2 degrees Celsius, or 3.6 degrees Fahrenheit, above 19th-century pre-industrial temperature levels, This is a much- discussed goal for a maximum allowable degree of climate change, and this aspirational target has now been formally adopted by the European Union and is supported by many other countries, as expressed, for example, in statements by both the G-8 and G-20 groups of nations. The Copenhagen Diagnosis also cites research supporting the position that, in order to have a reasonable likelihood of avoiding the risk of dangerous climate disruption, defined by this 2 degree Celsius (or 3.6 degree Fahrenheit) limit, global emissions of greenhouse gases such as carbon dioxide must peak and then start to decline rapidly within the next five to ten years, reaching near zero well within this century.

NASA Adv. – GW Human Induced

There is no other viable explanation

Rahmstorf 8 – Professor of Physics of the Oceans [Richard Rahmstorf, of Physics of the Oceans at Potsdam University, Global Warming: Looking Beyond Kyoto. Edited by Ernesto Zedillo. “Anthropogenic Climate Change?” pg. 47]

The first and crucial piece of evidence is, of course, that the magnitude of the warming is what is expected from the anthropogenic perturbation of the radiation balance, so anthropogenic forcing is able to explain all of the temperature rise. As discussed here, the rise in greenhouse gases alone corresponds to 2.6 W/m of forcing. This by itself, after subtraction of the observed 0.6 W/nr of ocean heat uptake, would cause 1.6°C of warming since preinduslrial times for medium climate sensitivity (3°C). With a current "best guess" aerosol forcing of 1 W/m\ the expected warming is 0.8°C. The point here is not that it is possible to obtain the exact observed number—this is fortuitous because the amount of aerosol forcing is still very uncertain—but that the expected magnitude is roughly right. There can be little doubt that the anthropogenic forcing is large enough to explain most of the warming. Depending on aerosol forcing and climate sensitivity, it could explain a large fraction of the warming, or all of it, or even more warming than has been observed (leaving room for natural processes to counteract some of the warming). The second important piece of evidence is clear: there is no viable alternative explanation. In the scientific literature, no serious alternative hypothesis has been proposed to explain the observed global warming. Other possible causes, such as solar activity, volcanic activity, cosmic rays, or orbital cycles, arc well observed, but they do not show trends capable of explaining the observed warming. Since 1978, solar irradiance has been measured directly from satellites and shows the well-known eleven-year solar cycle, but no trend.44 There arc various estimates of solar variability before this time, based on sunspot numbers, solar cycle length, the geomagnetic AA index, neutron monitor data, and carbon- 1 A data. These indicate that solar activity probably increased somewhat up to 1940. While there is disagreement about the variation in previous centuries, different authors agree that solar activity did not significantly increase during the last sixty-five years.''11 Therefore, this cannot explain the warming, and neither can any of the other factors mentioned. Models driven by natural factors only, leaving the anthropogenic forcing aside, show a cooling in the second half of the twentieth century (for an example, see figure 2-2, panel a, in chapter 2 of this volume). The trend in the sum of natural forcings is downward.

Warming is real and anthropogenic – NOAA consensus – final panel before the IPCC

Blunden, Arndt, and Baringer et al 10 [Jessica Blunden, \* NOAA/NESDIS National Climatic Data Center, N.C., Derek Arndt, NOAA/NESDIS National Climatic Data Center, Molly O. Baringer, NOAA/OAR Atlantic Oceanographic and Meteorological Laboratory, Florida State of the Climate in 2010, <http://www1.ncdc.noaa.gov/pub/data/cmb/bams-sotc/climate-assessment-2010-lo-rez.pdf>]

Several large-scale climate patterns influenced climate conditions and weather patterns across the globe during 2010. The transition from a warm El Niño phase at the beginning of the year to a cool La Niña phase by July contributed to many notable events, ranging from record wetness across much of Australia to historically low Eastern Pacific basin and near-record high North Atlantic basin hurricane activity. The remaining five main hurricane basins experienced below- to well-below-normal tropical cyclone activity. The negative phase of the Arctic Oscillation was a major driver of Northern Hemisphere temperature patterns during 2009/10 winter and again in late 2010. It contributed to record snowfall and unusually low temperatures over much of northern Eurasia and parts of the United States, while bringing above-normal temperatures to the high northern latitudes. The February Arctic Oscillation Index value was the most negative since records began in 1950. The 2010 average global land and ocean surface temperature was among the two warmest years on record.The Arctic continued to warm at about twice the rate of lower latitudes. The eastern and tropical Pacific Ocean cooled about 1°C from 2009 to 2010, reflecting the transition from the 2009/10 El Niño to the 2010/11 La Niña. Ocean heat fluxes contributed to warm sea surface temperature anomalies in the North Atlantic and the tropical Indian and western Pacific Oceans. Global integrals of upper ocean heat content for the past several years have reached values consistently higher than for all prior times in the record, demonstrating the dominant role of the ocean in the Earth’s energy budget. Deep and abyssal waters of Antarctic origin have also trended warmer on average since the early 1990s. Lower tropospheric temperatures typically lag ENSO surface fluctuations by two to four months, thus the 2010 temperature was dominated by the warm phase El Niño conditions that occurred during the latter half of 2009 and early 2010 and was second warmest on record. The stratosphere continued to be anomalously cool. Annual global precipitation over land areas was about five percent above normal. Precipitation over the ocean was drier than normal after a wet year in 2009. Overall, saltier (higher evaporation) regions of the ocean surface continue to be anomalously salty, and fresher (higher precipitation) regions continue to be anomalously fresh. This salinity pattern, which has held since at least 2004, suggests an increase in the hydrological cycle. Sea ice conditions in the Arctic were significantly different than those in the Antarctic during the year. The annual minimum ice extent in the Arctic—reached in September—was the third lowest on record since 1979. In the Antarctic, zonally averaged sea ice extent reached an all-time record maximum from mid-June through late August and again from mid-November through early December. Corresponding record positive Southern Hemisphere Annular Mode Indices influenced the Antarctic sea ice extents. Greenland glaciers lost more mass than any other year in the decade-long record. The Greenland Ice Sheet lost a record amount of mass, as the melt rate was the highest since at least 1958, and the area and duration of the melting was greater than any year since at least 1978. High summer air temperatures and a longer melt season also caused a continued increase in the rate of ice mass loss from small glaciers and ice caps in the Canadian Arctic. Coastal sites in Alaska show continuous permafrost warming and sites in Alaska, Canada, and Russia indicate more significant warming in relatively cold permafrost than in warm permafrost in the same geographical area. With regional differences, permafrost temperatures are now up to 2°C warmer than they were 20 to 30 years ago. Preliminary data indicate there is a high probability that 2010 will be the 20th consecutive year that alpine glaciers have lost mass. Atmospheric greenhouse gas concentrations continued to rise and ozone depleting substances continued to decrease. Carbon dioxide increased by 2.60 ppm in 2010, a rate above both the 2009 and the 1980–2010 average rates**.** The global ocean carbon dioxide uptake for the 2009 transition period from La Niña to El Niño conditions, the most recent period for which analyzed data are available, is estimated to be similar to the long-term average. The 2010 Antarctic ozone hole was among the lowest 20% compared with other years since 1990, a result of warmer-than-average temperatures in the Antarctic stratosphere during austral winter between mid-July and early September.

NASA Adv. – Prefer Our Evidence

Climate consensus is real – climate skeptics hyperbolize difference

Somerville 11 – Professor of Oceanography @ UCSD [Richard Somerville, Distinguished Professor Emeritus and Research Professor at Scripps Institution of Oceanography at the University of California, San Diego, Coordinating Lead Author in Working Group I for the 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 3-8-2011, “CLIMATE SCIENCE AND EPA'S GREENHOUSE GAS REGULATIONS,” CQ Congressional Testimony, Lexis]

It is a standard tactic of many climate "skeptics" or "contrarians" (terms commonly used to denote those who reject central findings of mainstream climate change science) to try to frame this issue in terms of the whole edifice of modern climate science hanging from some slender thread. Thus, if a given scientist uses intemperate language, or a particular measurement is missing from an archive, or a published paper has a minor mistake in it, the whole unstable scientific structure comes tumbling down, or so the skeptics would have people believe. In fact, climate change science is not at all fragile or vulnerable, and there are multiple lines of evidence in support of every one of its main conclusions. That is what the 2007 IPCC AR4 report says. It remains definitive. Historians of science tell us that the overwhelming degree of scientific agreement on climate change is rare for such a complex issue. A Galileo does come along every few hundred years to reveal fundamental errors in the prevailing understanding and thus to revolutionize a branch of science. However, almost all the people who think they are a Galileo are simply wrong. Facts matter.

NASA Adv. – Prefer Our Evidence – Standards

\*\*\*This card also defends public education about global warming

There should be an extremely high standard of evidence in debates about global warming – current climate skepticism ignores peer-review, comes from unspecialized writers, cherry picks evidence and is informed by ideology

Somerville 11 – Professor of Oceanography @ UCSD [Richard Somerville, Distinguished Professor Emeritus and Research Professor at Scripps Institution of Oceanography at the University of California, San Diego, Coordinating Lead Author in Working Group I for the 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 3-8-2011, “CLIMATE SCIENCE AND EPA'S GREENHOUSE GAS REGULATIONS,” CQ Congressional Testimony, Lexis]

Although the expert community is in wide agreement on the basic results of climate change science, as assessed in AR4 and The Copenhagen Diagnosis, much confusion exists among the general public and politicians in many countries, as polling data convincingly shows. In my opinion, many people need to learn more about the nature of junk or fake science, so they will be better equipped to recognize and reject it. There are a number of warning signs that can help identify suspicious claims. One is failure to rely on and cite published research results from peer- reviewed journals. Trustworthy science is not something that appears first on television or the Internet. Reputable scientists first announce the results of their research by peer-reviewed publication in well-regarded scientific journals. Peer review is not a guarantee of excellent science, but the lack of it is a red flag. Peer review is a necessary rather than a sufficient criterion. Another warning sign is a lack of relevant credentials on the part of the person making assertions, especially education and research experience in the specialized field in question. For example, it is not essential to have earned a Ph. D. degree or to hold a university professorship. It is important, however, that the person be qualified, not in some general broad scientific area, such as physics or chemistry, but in the relevant specialty. Accomplishments and even great distinction in one area of science do not qualify anybody to speak authoritatively in a very different area. We would not ask even an expert cardiologist for advice on, say, dentistry. One should inquire whether the person claiming expertise in some area of climate science has done first-person research on the topic under consideration and published it in reputable peer-reviewed journals. Is the person actively participating in the research area in question, or simply criticizing it from the vantage point of an outsider? One should be suspicious of a lack of detailed familiarity with the specific scientific topic and its research literature. Good science takes account of what is already known and acknowledges and builds on earlier research by others. Other warning signs include a blatant failure to be objective and to consider all relevant research results, both pro and con a given position. Scientific honesty and integrity require wide- ranging and thorough consideration of all the evidence that might bear on a particular question. Choosing to make selective choices among competing evidence, so as to emphasize those results that support a given position, while ignoring or dismissing any findings that do not support it, is a practice known as "cherry picking" and is a hallmark of poor science or pseudo-science. Mixing science with ideology or policy or personalities is never justified in research. Scientific validity has nothing to do with political viewpoints. There are no Republican or Democratic thermometers. Whether a given politician agrees or disagrees with a research finding is absolutely unimportant scientifically. Science can usefully inform the making of policy, but only if policy considerations have not infected the science. Similarly, one should always be alert to the risk of bias due to political viewpoints, ideological preferences, or connections with interested parties. All sources of funding, financial interests and other potential reasons for bias should be openly disclosed. Finally, we must always be alert for any hint of delusions of grandeur on the part of those who would insist that they themselves are correct, while nearly everyone else in the entire field of climate science is badly mistaken. Scientific progress is nearly always incremental**,** with very few exceptions. Occasionally, an unknown lone genius in a humble position, such as the young Einstein doing theoretical physics while working as a clerk in a patent office, does indeed revolutionize a scientific field, dramatically overthrowing conventional wisdom. However, such events are exceedingly rare, and claims to be such a lone genius deserve the most severe scrutiny. For every authentic Einstein, there must be thousands of outright charlatans, as well as many more ordinary mortals who are simply very badly mistaken.

NASA Adv. – Prefer Our Evidence

Defense of peer-review, IPCC and James Hansen – criticism of climate denialism – funded by fossil fuel industry

Davies 8 – Professor of Geophysics @ ANU [Geoff Davies, PhD, Geophysicist at the Australian National University, 6-11-2008, “Why listen to scientists?.” Science Alert, http://www.sciencealert.com.au/opinions/20081106-17474.html]

Professor Don Aitkin’s recent promotion (PDF 258KB) of the “sceptical” view of global warming and the ensuing heated debates on several web sites bring to the fore the question of what authority attaches to the published conclusions and judgments of climate scientists. Professor Aitkin, who is not a scientist, is in no doubt himself that the more outspoken climate scientists have a “quasi-religious” attitude. That is the mild end of the spectrum of opinions of sceptics/denialists/contrarians. Most of the media and many politicians seem to have the view that scientists are just another interest group, and that scientists’ opinions are just opinions, to be heard or discarded like any others. The Australian government seems to credit only the very conservative end of climate scientists’ warnings, because it is acting as though we have many decades in which to adjust, and many years before anything serious needs to be under way. The big difference between scientists’ professional conclusions and those of others is that science has a pervasive and well-developed quality-control process. The first stage is called peer review. Any paper that is published in a reputable scientific journal must be given the OK by several other scientists in the same field. Furthermore, after publication a paper will be read critically by many more scientists, and it is not uncommon for conclusions to be challenged in subsequent publications. For a paper to become widely acknowledged it must survive such scrutiny for a reasonable period, typically several years. All of this is on top of the fact that a scientific paper is based on observations of the world and on a large accumulation of well-tested regularities, such as the “laws” of physics. Few other groups have any comparable process. Certainly the media, politicians and climate sceptics have no such process.Most of the studies referred to by sceptics have either not been published in a relevant peer-reviewed scientific journal or have subsequently been challenged and found wanting in other peer-reviewed studies. The peer-review process is far from perfect, but it yields a product distinctly less unreliable than all the other opinions flying around. The process of the Intergovernmental Panel on Climate Change (IPCC) adds another layer of caution. Basically the IPCC gets a large number of relevant scientists to step back from the front-line disputes and ask “What can most of us agree on?”. Sceptics who dismiss all of the science because there are many disputes miss or obfuscate this basic aspect of IPCC assessments. There is a degree of judgment involved in the IPCC process, and in virtually any public summary by a climate scientist. Some would claim judgment is not the job of scientists; it is the job of politicians and others. But scientists are the best placed to judge the state of knowledge in their field. If their conclusions are potentially of great import, then they have a responsibility to state their best professional judgment. The claim by Professor Aitkin and many other sceptics that climate scientists don’t discuss the uncertainties in their conclusions and judgments simply misrepresents or misperceives the abundant information on uncertainties. Even the IPCC’s most terse summary statements clearly acknowledge uncertainty when they say, for example, “Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations” [emphasis in original]. The term “very likely” is specifically defined in the IPCC summaries to mean the “assessed likelihood, using expert judgment”, is greater than 90 per cent. Clive Hamilton contrasts the scientific and IPCC processes with those of many sceptics (see Atkin’s response here). He traces connections from relatively naïve people like Professor Aitkin back to people and web sites funded by ExxonMobil and others. Sceptics love to question the motives of climate scientists, but rarely mention the motives of the very powerful multi-trillion-dollar fossil fuel industry, parts of which are actively promoting doubt and disinformation in exactly the manner used by the tobacco industry for many years. Observations from the past two or three years, too recent to have been included in the 2007 IPCC Reports, show disturbing signs that the Earth’s response to our activities is happening much faster than expected. The most dramatic sign is a sudden acceleration of the rate of shrinkage of Arctic sea ice. Prominent NASA climate scientist Dr James Hansen is perhaps the most vocal, but far from alone, in arguing that the Earth may be very close to a tipping point beyond which large, unstoppable and irreversible climate change could occur. Scientific issues are not settled by appeals to authority, nor by a vote. That is not the issue here. The issue is whether scientists’ professional judgments have weight. Those in strategic positions in our society, like politicians and journalists, who treat scientists’ collective professional judgments as no better than any other opinion are being seriously irresponsible. You can ignore the IPCC if you want, but you should realise that its most recent assessment may have seriously understated the global warming problem. You can ignore James Hansen if you want, but you should know that his judgments from two or three decades ago are being broadly vindicated.

NASA Adv. – AT: CO2 is Natural

Co2 is attributable to human-causes

McCarty 10 – Professor of Biological Oceanography @ Harvard [James McCarty, Professor of Biological Oceanography, at Harvard University, 5-6-2010, “Committee on House Select Energy Independence and Global Warming,” CQ Congressional Testimony, Lexis]

Barnett et al. (2005) demonstrated that the observed changes in ocean heat-content since the 1960s are consistent with what would be expected from the accumulation of greenhouse gases from human activities, and that these patterns in warming cannot be solely explained by natural cycles, solar cycles or volcanic activity. Vast numbers of studies have corroborated these analyses, and there is no credible challenge to their validity. Multiple paths of research provide consistent and irrefutable evidence that the C02 increase in the atmosphere since the early 1800s is arising from human activities. Initially land use caused much of the change - forest clearing and soil tilling practices facilitate the conversion of living and dead organic material to C0z, and its release to the atmosphere. With a growing population and its needs for energy for heating, manufacturing, and lighting and increasing dependence on the internal combustion engine, fossil fuel combustion became the dominant, human-caused source of C02 release to the atmosphere. Stable and radioactive isotopes of carbon provide unambiguous evidence that the C02 accumulating in the atmosphere is due to human activities.

NASA Adv. – AT: Science is Indeterminate

Even if science isn’t entirely conclusive, it must be included in debates about warming

Somerville 8 – Professor of Oceanography @ UCSD [Richard Somerville, Distinguished Professor Emeritus and Research Professor at Scripps Institution of Oceanography at the University of California, San Diego, Coordinating Lead Author in Working Group I for the 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change, The Forgiving Air, pg. 159]

In the case of climate change, just as with ozone depletion, our past actions may well have already committed the Earth to future change. If the theories of how climate will respond to an increased greenhouse effect are even approximately valid, then we've already committed our planet to substantial climate change. And, because scientific understanding is still seriously incomplete, we'll inevitably be making decisions that may have far-reaching consequences without having at hand all the scientific knowledge that we'd like. We've found compelling reasons to believe that the world should accelerate a transition to nonfossil primary energy sources. Should the countries of the world follow the model of France, which generates about three-fourths of its electricity from nuclear power? There arc serious disadvantages to nuclear power, as we've seen. Should humankind instead put increased efforts into developing renewable energy resources, like solar, wind, hydroelectric, geothermal, and biomass, all the sources of energy other than nuclear and fossil fuels? Should governments emphasize energy conservation and efficiency, which have many side benefits? I think so, though others disagree. After all, if you change your choice of cars and drive one that uses less fuel, or if you drive less, you not only help slow' the increase in the greenhouse effect by putting out less carbon dioxide from the tailpipe, you may also help reduce smog and save yourself some money—and perhaps even improve political stability in the Middle East. So there arc many ramifications to these choices. But the scientific element in these discussions is critical. You can't make a sensible decision about how to have an environmentally sustainable planet in the future if you don't have an understanding of the consequences of actions today—actions such as releasing CFCs into the atmosphere or burning fossil fuels and making carbon dioxide. The role of science here is central.

NASA Adv. – AT: “We Have Peer Reviewed Evidence”

Peer review is not a sufficient condition to disprove climate science – balanced assessments like ACIA and IPCC overcome single skeptics -most work is submitted outside of relevant fields -they are a minority -they are unqualified -reviewers or editors have agendas that invalidate the paper’s conclusions -they leak through because of mass publication

Mann and Schmidt 5 – Both professors @ Major Research institutions [Michael Mann, Professor of Climatology @ Penn State University, Gavin Schmidt, Professor of Research Science @ Columbia, 1-2005, “Peer Review: A Necessary But Not Sufficient Condition,” http://www.realclimate.org/index.php/archives/2005/01/peer-review-a-necessary-but-not-sufficient-condition/]

On this site we emphasize conclusions that are supported by “peer-reviewed” climate research. That is, research that has been published by one or more scientists in a scholarly scientific journal after review by one or more experts in the scientists’ same field (‘peers’) for accuracy and validity. What is so important about “Peer Review”? As Chris Mooney has lucidly put it: [Peer Review] is an undisputed cornerstone of modern science. Central to the competitive clash of ideas that moves knowledge forward, peer review enjoys so much renown in the scientific community that studies lacking its imprimatur meet with automatic skepticism. Academic reputations hinge on an ability to get work through peer review and into leading journals; university presses employ peer review to decide which books they’re willing to publish; and federal agencies like the National Institutes of Health use peer review to weigh the merits of applications for federal research grants. Put simply, peer review is supposed to weed out poor science. However, it is not foolproof — a deeply flawed paper can end up being published under a number of different potential circumstances: (i) the work is submitted to a journal outside the relevant field (e.g. a paper on paleoclimate submitted to a social science journal) where the reviewers are likely to be chosen from a pool of individuals lacking the expertise to properly review the paper, (ii) too few or too unqualified a set of reviewers are chosen by the editor, (iii) the reviewers or editor (or both) have agendas, and overlook flaws that invalidate the paper’s conclusions, and (iv) the journal may process and publish so many papers that individual manuscripts occasionally do not get the editorial attention they deserve. Thus, while un-peer-reviewed claims should not be given much credence, just because a particular paper has passed through peer review does not absolutely insure that the conclusions are correct or scientifically valid. The “leaks” in the system outlined above unfortunately allow some less-than-ideal work to be published in peer-reviewed journals. This should therefore be a concern when the results of any one particular study are promoted over the conclusions of a larger body of past published work (especially if it is a new study that has not been fully absorbed or assessed by the community). Indeed, this is why scientific assessments such as the Arctic Climate Impact Assessment (ACIA), or the Intergovernmental Panel on Climate Change (IPCC) reports, and the independent reports by the National Academy of Sciences, are so important in giving a balanced overview of the state of knowledge in the scientific research community.

A single peer-reviewed study doesn’t disprove overall consensus

Mann and Schmidt 5 – Both professors @ Major Research institutions [Michael Mann, Professor of Climatology @ Penn State University, Gavin Schmidt, Professor of Research Science @ Columbia, 1-2005, “Peer Review: A Necessary But Not Sufficient Condition,” http://www.realclimate.org/index.php/archives/2005/01/peer-review-a-necessary-but-not-sufficient-condition/]

The current thinking of scientists on climate change is based on thousands of studies (Google Scholar gives 19,000 scientific articles for the full search phrase “global climate change”). Any new study will be one small grain of evidence that adds to this big pile, and it will shift the thinking of scientists slightly. Science proceeds like this in a slow, incremental way. It is extremely unlikely that any new study will immediately overthrow all the past knowledge. So even if the conclusions of the Shaviv and Veizer (2003) study discussed earlier, for instance, had been correct, this would be one small piece of evidence pitted against hundreds of others which contradict it. Scientists would find the apparent contradiction interesting and worthy of further investigation, and would devote further study to isolating the source of the contradiction. They would not suddenly throw out all previous results. Yet, one often gets the impression that scientific progress consists of a series of revolutions where scientists discard all their past thinking each time a new result gets published. This is often because only a small handful of high-profile studies in a given field are known by the wider public and media, and thus unrealistic weight is attached to those studies. New results are often over-emphasised (sometimes by the authors, sometimes by lobby groups) to make them sound important enough to have news value. Thus “bombshells” usually end up being duds.

NASA Adv. – AT: Urban Heat Island Effect

Not relevant to warming trends -tainted stations actually show less warming than good stations, but it’s statistically negligible

Muller 11 – Professor of Physics @ Berkeley [Richard Muller, Professor of Physics @ Berkeley, 3-31-2011, “Climate Change Policy Issues,” CQ Congressional Testimony, Lexis]

Let me now address the problem of Poor Temperature Station Quality Many temperature stations in the U.S. are located near buildings, in parking lots, or close to heat sources. Anthony Watts and his team has shown that most of the current stations in the US Historical Climatology Network would be ranked "poor" by NOAA's own standards, with error uncertainties up to 5 degrees C. Did such poor station quality exaggerate the estimates of global warming? We've studied this issue, and our preliminary answer is no. The Berkeley Earth analysis shows that over the past 50 years the poor stations in the U.S. network do not show greater warming than do the good stations. Thus, although poor station quality might affect absolute temperature, it does not appear to affect trends, and for global warming estimates, the trend is what is important. Our key caveat is that our results are preliminary and have not yet been published in a peer reviewed journal. We have begun that process of submitting a paper to the Bulletin of the American Meteorological Society, and we are preparing several additional papers for publication elsewhere. NOAA has already published a similar conclusion - that station quality bias did not affect estimates of global warming based on a smaller set of stations, and Anthony Anthony Watts and his team have a paper submitted, which is in late stage peer review, using over 1000 stations, but it has not yet been accepted for publication and I am not at liberty to discuss their conclusions and how they might differ. We have looked only at average temperature changes, and additional data needs to be studied, to look at (for example) changes in maximum and minimum temperatures. In fact, in our preliminary analysis the good stations report more warming in the U.S. than the poor stations by 0.009 0.009 degrees per decade, opposite to what might be expected, but also consistent with zero. We are currently checking these results and performing the calculation in several different ways. But we are consistently finding that there is no enhancement of global warming trends due to the inclusion of the poorly ranked US stations.

Has zero influence on climate modeling

Archer 9 – Professor of Geophysical Sciences @ Chicago [David Archer, professor of geophysical sciences at the University of Chicago, “The Long Thaw,” pg. 32]

One oft-discussed issue with regard to the reconstruction of average temperature is called the urban heat island effect. Paved land is measurably warmer than vegetated land, no doubt about it, because vegetated land cools by evaporation. The question is whether any warming in the computed average temperature could actually be the urban heat island effect instead of global warming. Hot urban centers are part of the Earth, and they do contribute to the average temperature of the Earth, but their warmth is not caused by rising CO2 concentration. The easiest solution is to throw out urban data, by picking it out by hand, to leave the average temperature of the non-urban Earth. This is a subjective, imprecise task, but replicate studies find that it makes little difference to the global average whether urban areas are excluded or not. It turns out to be a non-issue. Independent, competing studies produce very similar-looking global average land temperature records, regardless of how they deal with urban heat island effects (Figure 4). So unless someone comes up with believable proof that the urban heat island is important, we'll not worry about it.

NASA Adv. – Yes Positive Feedbacks

Warming creates positive feedbacks – exponentially increases the impact – on the brink

Hansen 8 – Professor of Earth and Environmental Science [James E. Hanson, head of the NASA Goddard Institute for Space Studies in New York City and adjunct professor in the Department of Earth and Environmental Science at Columbia University, Al Gore’s science advisor, “Briefing before the Select Committee on Energy Independence and Global Warming,” US House of Representatives, 6-23-2008, “Twenty years later: tipping points near on global warming,” <http://www.columbia.edu/~jeh1/2008/TwentyYearsLater_20080623.pdf>]

Fast feedbacks—changes that occur quickly in response to temperature change—amplify the initial temperature change, begetting additional warming. As the planet warms, fast feedbacks include more water vapor, which traps additional heat, and less snow and sea ice, which exposes dark surfaces that absorb more sunlight. Slower feedbacks also exist. Due to warming, forests and shrubs are moving poleward into tundra regions. Expanding vegetation, darker than tundra, absorbs sunlight and warms the environment. Another slow feedback is increasing wetness (i.e., darkness) of the Greenland and West Antarctica ice sheets in the warm season. Finally, as tundra melts, methane, a powerful greenhouse gas, is bubbling out. Paleoclimatic records confirm that the long-lived greenhouse gases— methane, carbon dioxide, and nitrous oxide—all increase with the warming of oceans and land. These positive feedbacks amplify climate change over decades, centuries, and longer. The predominance of positive feedbacks explains why Earth’s climate has historically undergone large swings: feedbacks work in both directions, amplifying cooling, as well as warming, forcings. In the past, feedbacks have caused Earth to be whipsawed between colder and warmer climates, even in response to weak forcings, such as slight changes in the tilt of Earth’s axis.2 The second fundamental property of Earth’s climate system, partnering with feedbacks, is the great inertia of oceans and ice sheets. Given the oceans’ capacity to absorb heat, when a climate forcing (such as increased greenhouse gases) impacts global temperature, even after two or three decades, only about half of the eventual surface warming has occurred. Ice sheets also change slowly, although accumulating evidence shows that they can disintegrate within centuries or perhaps even decades. The upshot of the combination of inertia and feedbacks is that additional climate change is already “in the pipeline”: even if we stop increasing greenhouse gases today, more warming will occur. This is sobering when one considers the present status of Earth’s climate. Human civilization developed during the Holocene (the past 12,000 years). It has been warm enough to keep ice sheets off North America and Europe, but cool enough for ice sheets to remain on Greenland and Antarctica. With rapid warming of 0.6°C in the past 30 years, global temperature is at its warmest level in the Holocene.3 The warming that has already occurred, the positive feedbacks that have been set in motion, and the additional warming in the pipeline together have brought us to the precipice of a planetary tipping point. We are at the tipping point because the climate state includes large, ready positive feedbacks provided by the Arctic sea ice, the West Antarctic ice sheet, and much of Greenland’s ice. Little additional forcing is needed to trigger these feedbacks and magnify global warming. If we go over the edge, we will transition to an environment far outside the range that has been experienced by humanity, and there will be no return within any foreseeable future generation. Casualties would include more than the loss of indigenous ways of life in the Arctic and swamping of coastal cities. An intensified hydrologic cycle will produce both greater floods and greater droughts. In the US, the semiarid states from central Texas through Oklahoma and both Dakotas would become more drought-prone and ill suited for agriculture, people, and current wildlife. Africa would see a great expansion of dry areas, particularly southern Africa. Large populations in Asia and South America would lose their primary dry season freshwater source as glaciers disappear. A major casualty in all this will be wildlife.

NASA Adv. – Must Act Now

Must act now – solves risky and expensive solutions in crisis

Carnesale 11 – Professor of Engineering @ UCLA [Albert Carnesale, PhD in Nuclear Engineering, UCLA Chancellor Emeritus, Professor of Public Policy and Mechanical and Aerospace Engineering, 3-2011, “America’s Climate Choices,” http://americasclimatechoices.org/ACC\_Final\_Report\_Brief04.pdf]

In the judgment of this report’s authoring committee, the environmental, economic, and humanitarian risks posed by climate change indicate a pressing need for substantial action to limit the magnitude of climate change and to prepare for adapting to its impacts. There are many reasons why it is imprudent to delay such actions, for instance: • The sooner that serious efforts to reduce greenhouse gas emissions proceed, the lower the risks posed by climate change, and the less pressure there will be to make larger, more rapid, and potentially more expensive reductions later. • Some climate change impacts, once manifested, will persist for hundreds or even thousands of years, and will be difficult or impossible to “undo.” In contrast, many actions taken to respond to climate change could be reversed or scaled back, if they some how prove to be more stringent than actually needed.

Only action now solves future catastrophe

Antholis and Talbott 10 – Director and President @ Brookings [William Antholis, managing director of the Brookings Institution and a senior fellow in Governance Studies, former director of studies at the German Marshall Fund of the United States, and Strobe Talbott, president of the Brookings Institution, deputy Sec. of State under Clinton, “The Global Warming Tipping Point,” The Globalist, http://www.theglobalist.com/storyid.aspx?StoryId=8523]

Moreover, we need to start reductions now in order to slow temperature rise later. Even if we could flip a switch and shut down all emissions, gases that are already in the atmosphere will continue to trap heat for some time to come. Once emitted into the atmosphere, a molecule of carbon dioxide, or CO2, lingers for decades. So gases emitted today are added to ones that have been around for 50 years or more. The current concentration of CO2 in the atmosphere is about 385 parts per million (ppm) and growing by two ppm each year. If we continue with current warming trends, the globe could keep warming for millennia. Even if the human species is biologically resilient enough to survive for centuries, the human enterprise may well be hard to maintain in anything like its current form. Today, humanity is cumulatively emitting, on a yearly basis, around 30 gigatons of CO2. A gigaton is a billion tons. Thirty gigatons is about the weight of 8,000 Empire State Buildings, which, if stacked one on top of another, would reach almost 2,000 miles into space. Of those 30 gigatons of CO2 that will be emitted this year, just under six gigatons are from the United States. To keep CO2 concentrations below 400 ppm and thereby keep temperature rise below 3.6°F, we should use the next four decades to cut the current output of 30 gigatons a year approximately in half. Thirty gigatons is about the weight of 8,000 Empire State Buildings, which, if stacked one on top of another, would reach almost 2,000 miles into space. So that is another target for mitigation: a staged process that would bring the global annual output down to 15 gigatons a year by 2050. To reach that goal, we have to build a new worldwide system for generating and using energy. We have to begin quickly in order to achieve the bulk of the necessary cuts between 2020 and 2035 so that there is some hope that, by 2050, emissions will have come down to 15 gigatons, concentrations will have stabilized below the 400 ppm level — and temperature rise will have flattened out before hitting the 3.6°F mark. At the heart of this mammoth undertaking is a transition from a high-carbon to a low-carbon global economy — that is, one that is powered as much as possible by forms of energy that do not burn fossil fuels and therefore do not pump CO2 into the atmosphere.

Acting now is key to avoiding tipping points

Strom 7 – Professor of Planetary Science @ U of Arizona [Robert Strom, studied climate change for 15 years, the former Director of the Space Imagery Center, Professor of planetary sciences @ U of Arizona, "Hot House", SpringerLink, p. 123]

We do not have time to spare. We must act now. Delaying action will require a much greater effort later to achieve the same temperature target. Even a 5-year delay is significant, given the current increase in C02 emissions. If action is delayed 20 years, rates of emission reduction will need to be 3 to 7 times greater to meet the same temperature target (Schellnhuber et al., 2006). In the absence of urgent and strenuous reduction in greenhouse gas emissions, the world will be committed to at least a 0.5 to 2 °C rise by 2050, and it could be considerably more because of the factors mentioned earlier. None of the greenhouse gas or temperature projections take into account the possibility of crossing a threshold that leads to an abrupt climate warming by the catastrophic release of natural greenhouse gases or some other cause. Although this is considered unlikely, we do not know in detail how these abrupt changes are triggered. Could the rise of atmospheric greenhouse gases and the complex interactions of other warming conditions set one of these events into motion? We do not know, but if it happened we would be in the worst trouble imaginable.

NASA Adv. – Brink of Runaway Warming

Tipping points now – on the brink of runaway warming

Speth 8 – Dean of Yale school of Forestry [James Speth, dean of the Yale School of Forestry and Environmental Studies at Yale University, New Haven, Connecticut. Currently he serves the school as the Carl W. Knobloch, Jr. Dean and Sara Shallenberger Brown Professor in the Practice of Environmental Policy, The Bridge @ the Edge of the World, pg. 26]

The possibility of abrupt climate change is linked to what may be the most problematic possibility of all—"positive" feedback effects where the initial warming has effects that generate more warming. Several of these feedbacks are possible. First, the land's ability to store carbon could weaken. Soils and forests can dry out or burn and release carbon; less plant growth can occur, thus reducing nature's ability to remove carbon from the air. Second, carbon sinks in the oceans could also be reduced due to ocean warming and other factors. Third, the potent greenhouse gas methane could be released from peat bogs, wetlands, and thawing permafrost, and even from the methane hydrates in the oceans, as the planet warms and changes. Finally, the earth's albedo, the reflectivity of the earth's surface, is slated to be reduced as large areas now covered by ice and snow diminish or are covered by meltwater. All these effects would tend to make warming self-reinforcing, possibly leading to a greatly amplified greenhouse effect. The real possibility of these amplifying feedbacks has alarmed some of our top scientists. James Hansen, the courageous NASA climate scientist, is becoming increasingly outspoken as his investigations lead him to more and more disturbing conclusions. He offered the following assessment in 2007: "Our home planet is now dangerously near a 'tipping point.' Human-made greenhouse gases are near a level such that important climate changes may proceed mostly under the climate system's own momentum. Impacts would include extermination of a large fraction of species on the planet, shifting of climatic zones due to an intensified hydrologic cycle with effects on freshwater availability and human health, and repeated worldwide coastal tragedies associated with storms and a continuously rising sea level. .. . "Civilization developed during the Holocene, a period of relatively tranquil climate now almost 12,000 years in duration. The planet has been warm enough to keep ice sheets off North America and Europe, but cool enough for ice sheets on Greenland and Antarctica to be stable. Now, with rapid warming of o.6°C in the past 30 years, global temperature is at its warmest level in the Holocene. "This warming has brought us to the precipice of a great 'tipping point” If we go over the edge, it will be a transition to 'a different planet,' an environment far outside the range that has been experienced by humanity. There will be no return within the lifetime of any generation that can be imagined, and the trip will exterminate a large fraction of species on the planet**.**

NASA Adv. – Brink of Biodiversity Loss

On the brink of massive biodiversity loss

Speth 8 – Dean of Yale school of Forestry [James Speth, dean of the Yale School of Forestry and Environmental Studies at Yale University, New Haven, Connecticut. Currently he serves the school as the Carl W. Knobloch, Jr. Dean and Sara Shallenberger Brown Professor in the Practice of Environmental Policy, The Bridge @ the Edge of the World, pg. 37]

The cumulative effect of all the factors is that species loss today is estimated to be about a thousand times the natural or normal rate that species go extinct.65 Many scientists believe we are on the brink of the sixth great wave of species loss on earth, the only one caused by humans. The World Conservation Union, which keeps the books on species, estimates that two of every five recognized species on the planet risk extinction, including one in eight birds, one in four mammals, and one in three amphibians.66 Almost 95 percent of the leather-back turtles in the Pacific have disappeared in the past twenty years;67 at least nine and perhaps 122 amphibian species have gone extinct since 1980;68 tigers are on the verge of extinction in the wild 69 populations of nearly half the world's waterbird species are in decline, and populations of twenty common American meadow birds like the bobwhite and the meadowlark have lost more than half their populations in forty years.

NASA Adv. – Extinction

Global Warming Causes Extinction

Romm 10 –former Acting Assistant Secretary of Energy for Energy Efficiency and Renewable Energy, [Jon Romm, Editor of Climate Progress, Senior Fellow at the American Progress, Fellow of the American Association for the Advancement of Science, “Disputing the “consensus” on global warming,” <http://climateprogress.org/2010/06/16/scientific-consensus-on-global-warming-climate-science/>]

A good example of how scientific evidence drives our understanding concerns how we know that humans are the dominant cause of global warming. This is, of course, the deniers’ favorite topic. Since it is increasingly obvious that the climate is changing and the planet is warming, the remaining deniers have coalesced to defend their Alamo — that human emissions aren’t the cause of recent climate change and therefore that reducing those emissions is pointless. Last year, longtime Nation columnist [Alexander Cockburn wrote](http://www.counterpunch.org/cockburn04282007.html%22%20%5Ct%20%22_blank), “There is still zero empirical evidence that anthropogenic production of CO2 is making any measurable contribution to the world’s present warming trend. The greenhouse fearmongers rely entirely on unverified, crudely oversimplified computer models to finger mankind’s sinful contribution.” In fact, the evidence is amazingly strong. Moreover, if the relatively complex climate models are oversimplified in any respect, it is by omitting amplifying feedbacks and other factors that suggest human-caused climate change will be worse than is widely realized. The [IPCC concluded](http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Ch09.pdf%22%20%5Ct%20%22_blank) last year: “Greenhouse gas forcing has very likely (>90 percent) caused most of the observed global warming over the last 50 years. This conclusion takes into account … the possibility that the response to solar forcing could be underestimated by climate models.” Scientists have come to understand that “forcings” (natural and human-made) explain most of the changes in our climate and temperature both in recent decades and over the past millions of years. The primary human-made forcings are the heat-trapping greenhouse gases we generate, particularly carbon dioxide from burning coal, oil and natural gas. The natural forcings include fluctuations in the intensity of sunlight (which can increase or decrease warming), and major volcanoes that inject huge volumes of gases and aerosol particles into the stratosphere (which tend to block sunlight and cause cooling**)….** Over and over again, scientists have demonstrated that observed changes in the climate in recent decades can only be explained by taking into account the observed combination of human and natural forcings**.** Natural forcings alone just don’t explain what is happening to this planet. For instance, in April 2005, one of the nation’s top climate scientists, NASA’s James Hansen, led a team of scientists that made “precise measurements of increasing ocean heat content over the past 10 years,” which revealed that the Earth is absorbing far more heat than it is emitting to space, confirming what earlier computer models had shown about warming. [Hansen called](http://www.columbia.edu/~jeh1/imbalance_release.pdf%22%20%5Ct%20%22_blank) this energy imbalance the “smoking gun” of climate change, and said, “There can no longer be genuine doubt that human-made gases are the dominant cause of observed warming.” Another 2005 study, led by the Scripps Institution of Oceanography, compared actual ocean temperature data from the surface down to hundreds of meters (in the Atlantic, Pacific and Indian oceans) with climate models and [concluded](http://www.sciencemag.org/cgi/content/abstract/1112418%22%20%5Ct%20%22_blank): A warming signal has penetrated into the world’s oceans over the past 40 years. The signal is complex, with a vertical structure that varies widely by ocean; it cannot be explained by natural internal climate variability or solar and volcanic forcing, but is well simulated by two anthropogenically [human-caused] forced climate models. We conclude that it is of human origin, a conclusion robust to observational sampling and model differences. Such studies are also done for many other observations: land-based temperature rise, atmospheric temperature rise, sea level rise, arctic ice melt, inland glacier melt, Greeland and Antarctic ice sheet melt, expansion of the tropics (desertification) and changes in precipitation. Studies compare every testable prediction from climate change theory and models (and suggested by paleoclimate research) to actual observations. How many studies? Well, the IPCC’s definitive treatment of the subject, “Understanding and Attributing Climate Change,” has 11 full pages of references, some 500 peer-reviewed studies. This is not a consensus of opinion. It is what scientific research and actual observations reveal. And the science behind human attribution has gotten much stronger in the past 2 years (see a recent literature review by the Met Office [here](http://www.metoffice.gov.uk/corporate/pressoffice/2010/pr20100305.html)). That brings us to another problem with the word “consensus.” It can mean “unanimity” or “the judgment arrived at by most of those concerned.” Many, if not most, people hear the second meaning: “consensus” as majority opinion. The scientific consensus most people are familiar with is the IPCC’s “Summary for Policymakers” reports. But those aren’t a majority opinion. Government representatives participate in a line-by-line review and revision of these summaries. So China, Saudi Arabia and that hotbed of denialism — the Bush administration — get to veto anything they don’t like. The deniers call this “politicized science,” suggesting the process turns the IPCC summaries into some sort of unscientific exaggeration. In fact, the reverse is true. The net result is unanimous agreement on a conservative or watered-down document. You could argue that rather than majority rules, this is “minority rules.” Last April, in an article titled “Conservative Climate,” [Scientific American](http://www.sciam.com/article.cfm?chanID=sa006&articleID=5B9E73AD-E7F2-99DF-3F71280BCE41ED77&colID=5" \t "_blank) noted that objections by Saudi Arabia and China led the IPCC to remove a sentence stating that the impact of human greenhouse gas emissions on the Earth’s recent warming is five times greater than that of the sun. In fact, lead author Piers Forster of the University of Leeds in England said, “The difference is really a factor of 10.” Then I discuss the evidence we had even back in 2008 that the IPCC was underestimating key climate impacts, a point I [update here](http://climateprogress.org/2010/02/18/ipcc-lowballs-impacts-pachauri-disband/). The bottom line is that recent observations and research make clear the planet almost certainly faces a greater and more imminent threat than is laid out in the IPCC reports. That’s why climate scientists are so desperate. That’s why they keep begging for immediate action. And that’s why the “consensus on global warming” is a phrase that should be forever retired from the climate debate. The leading scientific organizations in this country and around the world, including all the major national academies of science, aren’t buying into some sort of consensus of opinion. They have analyzed the science and observations and expressed their understanding of climate science and the likely impacts we face on our current emissions path — an understanding that has grown increasingly dire in recent years (see “[An illustrated guide to the latest climate science](http://climateprogress.org/2010/02/17/an-illustrated-guide-to-the-latest-climate-science/)” and “[An introduction to global warming impacts: Hell and High Water](http://climateprogress.org/2009/03/22/an-introduction-to-global-warming-impacts-hell-and-high-water/)“).

NASA Adv. – Biodiversity

Warming leads to invasive species – collapses biodiversity

Olmstead 11 – JD, founder of the CPC [James Olmstead, JD, founder of Conservation and Preservation Counsel, a law firm devoted to representing land trusts and landowners in land preservation acquisitions, 2011, “THE BUTTERFLY EFFECT: CONSERVATION EASEMENTS, CLIMATE CHANGE, AND INVASIVE SPECIES,” 38 B.C. Envtl. Aff. L. Rev. 41, Lexis]

Global warming will cause unpredictable and destabilizing migrations of species, many of which will become invasive in their new biomes. 237 Such invasions will cause extinctions, and extinctions will decrease biodiversity. 238 Without biodiversity we will lose ecological services. 239 We will also lose the complexity and uniqueness of each one of thousands of species that we will drive to extinction. Because land trusts are carrying most of the burden of saving natural lands in the United States and other nations, it falls to the land trust community, and to its oversight institutions such as the Land Trust Alliance, 240 to address the stark reality of climate-change-driven harmful invasions. Indeed, land trusts and the Land Trust Alliance must make it their prime imperative to alter this ecologically fatal trajectory we have embarked upon for the sake of wealth and convenience.

Warming collapses biodiversity – outweighs all alternate causes

Hansen 8 – Professor of Earth Sciences @ Columbia [James E Hansen, Head of the NASA Goddard Institute for Space Studies in New York City and adjunct professor in the Department of Earth and Environmental Science at Columbia University. Al Gore’s science advisor. Introductory chapter for the book State of the Wild. “Tipping point: Perspective of a Scientist.” April. http://www.columbia.edu/~jeh1/2008/StateOfWild\_20080428.pdf]

Climate change is emerging while the wild is stressed by other pressures— habitat loss, overhunting, pollution, and invasive species—and it will magnify these stresses. Species will respond to warming at differing paces, affecting many others through the web of ecological interactions. Phenological events, which are timed events in the life cycle that are usually tied to seasons, may be disrupted. Examples of phenological events include when leaves and flowers emerge and when animals depart for migration, breed, or hibernate. If species depend on each other during those times—for pollination or food— the pace at which they respond to warmer weather or precipitation changes may cause unraveling, cascading effects within ecosystems. Animals and plants respond to climate changes by expanding, contracting, or shifting their ranges. Isotherms, lines of a specific average temperature, are moving poleward by approximately thirty-five miles (56 km) per decade, meaning many species ranges may in turn shift at that pace.4 Some already are: the red fox is moving into Arctic fox territory, and ecologists have observed that 943 species across all taxa and ecosystems have exhibited measurable changes in their phenologies and/or distribution over the past several decades.5 However, their potential routes and habitat will be limited by geographic or human-made obstacles, and other species’ territories. Continued business-as-usual greenhouse gas emissions threaten many ecosystems, which together form the fabric of life on Earth and provide a wide range of services to humanity. Some species face extinction. The following examples represent a handful. Of particular concern are polar species, because they are being pushed off the planet. In Antarctica, Adelie and emperor penguins are in decline, as shrinking sea ice has reduced the abundance of krill, their food source.6 Arctic polar bears already contend with melting sea ice, from which they hunt seals in colder months. As sea ice recedes earlier each year, populations of polar bears in Canada have declined by about 20 percent, with the weight of females and the number of surviving cubs decreasing a similar amount. As of this writing, the US Fish and Wildlife Service is still considering protecting polar bears, but only after it was taken to court for failure to act on the mounting evidence that polar bears will suffer greatly due to global warming. 7 Life in many biologically diverse alpine regions is similarly in danger of being pushed off the planet. When a given temperature range moves up a mountain, the area with those climatic conditions becomes smaller and rockier, and the air thinner, resulting in a struggle for survival for some alpine species. In the Southwest US, the endemic Mount Graham red squirrel survives on a single Arizona mountain, an “island in the sky,” an isolated green spot in the desert. The squirrels, protected as an endangered species, had rebounded to a population of over 500, but their numbers have since declined to between 100 and 200 animals.8 Loss of the red squirrel will alter the forest because its middens are a source of food and habitat for chipmunks, voles, and mice. A new stress on Graham red squirrels is climatic: increased heat, drought, and fires. Heat-stressed forests are vulnerable to prolonged beetle infestation and catastrophic fires. Rainfall still occurs, but it is erratic and heavy, and dry periods are more intense. The resulting forest fires burn hotter, and the lower reaches of the forest cannot recover. In the marine world, loggerhead turtles are also suffering. These great creatures return to beaches every two to three years to bury a clutch of eggs. Hatchlings emerge after two months and head precariously to the sea to face a myriad of predators. Years of conservation efforts to protect loggerhead turtles on their largest nesting area in the US, stretching over 20 miles of Florida coastline, seemed to be stabilizing the South Florida subpopulation. 9 Now climate change places a new stress on these turtles. Florida beaches are increasingly lined with sea walls to protect against rising seas and storms. Sandy beaches seaward of the walls are limited and may be lost if the sea level rises substantially. Some creatures seem more adaptable to climate change. The armadillo, a prehistoric critter that has been around for over 50 million years, is likely to extend its range northward in the US. But the underlying cause of the climatic threat to the Graham red squirrel and other species—from grizzlies, whose springtime food sources may shift, to the isolated snow vole in the mountains of southern Spain—is “business-as-usual” use of fossil fuels. Predicted warming of several degrees Celsius would surely cause mass extinctions. Prior major warmings in Earth’s history, the most recent occurring 55 million years ago with the release of large amounts of Arctic methane hydrates,10 resulted in the extinction of half or more of the species then on the planet. Might the Graham red squirrel and snow vole be “saved” if we transplant them to higher mountains? They would have to compete for new niches— and there is a tangled web of interactions that has evolved among species and ecosystems. What is the prospect that we could understand, let alone reproduce, these complex interactions that create ecological stability? “Assisted migration” is thus an uncertain prospect. 11 The best chance for all species is a conscious choice by humans to pursue an alternative energy scenario to stabilize the climate.

Collapses half of all species

Stern 7 – Professor of Economics and Government [Nicholas Stern- Head of the British Government Economic Service, Former Head Economist for the World Bank, I.G. Patel Chair at the London School of Economics and Political Science, “The Economics of Climate Change: The Stern Review”, The report of a team commissioned by the British Government to study the economics of climate change led by Siobhan Peters, Head of G8 and International Climate Change Policy Unit, Cambridge University Press, p. 79-81]

Climate change is likely to occur too rapidly for many species to adapt. One study estimates that around 15 – 40% of species face extinction with 2°C of warming. Strong drying over the Amazon, as predicted by some climate models, would result in dieback of forest with the highest biodiversity on the planet. The warming of the 20th century has already directly affected ecosystems. Over the past 40 years, species have been moving polewards by 6 Km on average per decade, and seasonal events, such as flowering or egg-laying, have been occurring several days earlier each decade.72 Coral bleaching has become increasingly prevalent since the 1980s. Arctic and mountain ecosystems are acutely vulnerable – polar bears, caribou and white spruce have all experienced recent declines.73 Climate change has already contributed to the extinction of over 1 % of the world’s amphibian species from tropical mountains.74 Ecosystems will be highly sensitive to climate change (Table 3.4). For many species, the rate of warming will be too rapid to withstand. Many species will have to migrate across fragmented landscapes to stay within their “climate envelope” (at rates that many will not be able to achieve). Migration becomes more difficult with faster rates of warming. In some cases, the “climate envelope” of a species may move beyond reach, for example moving above the tops of mountains or beyond coastlines. Conservation reserves may find their local climates becoming less amenable to the native species. Other pressures from human activities, including land-use change, harvesting/hunting, pollution and transport of alien species around the world, have already had a dramatic effect on species and will make it even harder for species to cope with further warming. Since 1500, 245 extinctions have been recorded across most major species groups, including mammals, birds, reptiles, amphibians, and trees. A further 800 known species in these groups are threatened with extinction.7 A warming world will accelerate species extinctions and has the potential to lead to the irreversible loss of many species around the world, with most kinds of animals and plants affected (see below). Rising levels of carbon dioxide have some direct impacts on ecosystems and biodiversity,76 but increases in temperature and changes in rainfall will have even more profound effects. Vulnerable ecosystems are likely to disappear almost completely at even quite moderate levels of warming.77 The Arctic will be particularly hard hit, since many of its species, including polar bears and seals, will be very sensitive to the rapid warming predicted and substantial loss of sea ice (more detail in Chapter 5).78 1°C warming. At least 10% of land species could be facing extinction, according to one stud y.79 Coral reef bleaching will become much more frequent, with slow recovery, particularly in the southern Indian Ocean, Great Barrier Reef and the Caribbean.80 Tropical mountain habitats are very species rich and are likely to lose many species as suitable habitat disappears. 2°C warming. Around 15 – 40% of land species could be facing extinction, with most major species groups affected, including 25 – 60% of mammals in South Africa and 15 – 25% of butterflies in Australia. Coral reefs are expected to bleach annually in many areas, with most never recovering, affecting tens of millions of people that rely on coral reefs for their livelihood or food supply.81 This level of warming is expected to lead to the loss of vast areas of tundra and forest – almost half the low tundra and about one-quarter of the cool conifer forest according to one study. 82 3°C warming. Around 20 – 50% of land species could be facing extinction. Thousands of species may be lost in biodiversity hotspots around the world, e.g. over 40% of endemic species in some biodiversity hotspots such as African national parks and Queensland rain forest. 83 Large areas of coastal wetlands will be permanently lost because of sea level rise (up to one-quarter according to some estimates), with acute risks in the Mediterranean, the USA and South East Asia. Mangroves and coral reefs are at particular risk from rapid sea level rise (more than 5 mm per year) and their loss would remove natural coastal defences in many regions. Strong drying over the Amazon, according to some climate models, would result in dieback of forest with the highest biodiversity on the planet. 84 Temperatures could rise by more than 4 or 5°C if emissions continue unabated, but the full range of consequences at this level of warming have not been clearly articulated to date. Nevertheless, a basic understanding of ecological processes leads quickly to the conclusion that many of the ecosystem effects will become compounded with increased levels of warming, particularly since small shifts in the composition of ecosystems or the timing of biological events will have knock-on effects through the food- chain (e.g. loss of pollinators or food supply).85

Warming causes mass Co2 levels which kills biodiversity – Artic example

Barnes and Peck 08 – Both are part of the British Antarctic Survey, Natural Environment Research Council, [David K. A. Barnes, Lloyd S. Peck, Vulnerability of Antarctic shelf biodiversity to predicted regional warming, Vol. 37: 149–163, 2008 <http://www.feriaantarticaescolar.cl/doc/disponibles_inach/5%20Barnes-vulnerability%20Antarctic%20shelf%20biodiversity.pdf>]

The western Antarctic Peninsula (WAP) is one of the most rapidly changing ecosystems on the planet and an area of rich biodiversity, most of which has been described to lie on the continental shelf (Clarke & Johnston 2003). How will this rich and largely endemic fauna respond to current and predicted regional warming? There are 2 main approaches that have been used to analyse potential responses, physiological and ecological, and these have a marked schism in the predicted outcomes. Physiological experiments over the last few decades have suggested some marine ectotherms may be sensitive to even small increases in temperature, but some ecological information on distributions contrasts with such an assessment. With rates of global climate change accelerating, bridging the gap between these approaches and moving the field towards a realistic understanding of likely ecosystem responses is the focus of this manuscript. In the last decade we have gathered an unparalleled quantity and quality of information about past environmental change. Examination of gas bubbles and oxygen isotopes in ice cores from a variety of sites in Greenland and Antarctica have revealed the details of some atmospheric changes throughout the last and previous 7 glacial cycles (EPICA 2004). Comparison of trends of CO2, other drivers and temperature in ice cores have now given us a good picture of climate change in the past 800 thousand years (800 kyr) and, thus, the context for current change. Even recently (in the last interglacial period) our planet has been warmer than at present, and CO2, CH4 (methane) and surface temperature have all changed rapidly before, but we are now in a time of dramatic change unlike any for which we have a detailed record (EPICA 2004). Levels of atmospheric CO2 are now higher than at any point during the last 800 kyr, and are rising rapidly. Raupach et al. (2007) reported that the rate of global CO2 emissions has tripled from 1.1% yr–1 in the last decade to >3% yr–1 in the current decade. Historic records show that 21 of the hottest 22 yr (air temperatures) on record have been since 1980 and the 4 hottest years have all been in the last decade. This warming is unevenly distributed, with the most intensively warming areas concentrated around parts of the 2 polar regions (Hansen et al. 2006). The WAP is one of the localities showing the most rapidly warming air temperatures (King et al. 2003). Recently it was detected that a significant increase in sea temperatures has been building up in the Bellingshausen Sea over the last 50 yr (Meredith & King 2005). The decrease in the extent of arctic sea ice is regularly discussed with concern by the scientific and popular media, but the duration and extent of seasonal sea ice to the west of the Antarctic Peninsula (AP) has substantially decreased, with less acclaim (Zwally et al. 2002). Along the AP both the number of glaciers in retreat and the rate at which they are retreating have increased (Cook et al. 2005). Rapid rises in CO2 and temperature, and the physical responses to these, such as glacial retreat, surface freshening, ocean acidification, amongst others, have a drastic potential to influence life on earth. The earth’s system is, therefore, in a period of change unprecedented in recent geological time, and the AP is possibly the fastest changing site on the planet. It is in such places that we should look first to identify the changes in and responses of the species, communities and ecosystems living there. Although some changes over decades have been noted in both pelagic (Atkinson et al. 2004) and benthic (Barnes et al. 2006a) populations of the Southern Ocean, whether these are linked to regional warming is currently uncertain. There has been a marked response of life to elevated temperatures in the terrestrial environment of the AP (Walther et al. 2002). The high thermal capacity of water means that the physical rates of change in the sea are different. In addition, Antarctic marine animals differ considerably in their physiology, longevity, growth rates and many other aspects to the few types that live on land (Arntz et al. 1994, Peck et al. 2006). Amongst the traits that characterise Antarctic marine animals is that they may be amongst the most sensitive of any large region on earth to predicted climate change (Peck 2005, Clarke et al. 2007). In the current paper we concentrate on the marine environment around Antarctica about which we know most, i.e. the continental shelf (0 to 1000 m). We calculate, using a variety of sources (satellite imagery, aerial photo mosaics, swath bathymetry, existing bathymetric maps and estimates of grounding lines of ice-sheets), that the continental shelf around Antarctica covers about 4 376 000 km2 and that about 34% of the shelf currently lies under ice (Fig. 1). New areas of the continental shelf are emerging from parts of ice shelves, such as the Filchner and Larsen, which have collapsed, but ice shelves cyclically grow and their outer margins disintegrate. In the last few decades the Ross Ice Shelf has grown, so, despite the recent collapse of various ice shelves elsewhere around Antarctica, we calculate the net emergence of continental shelf from under ice sheets to be only approximate to 1% of Antarctica’s total continental shelf area, but if the Ross Ice Shelf entered a cycle of regression this could be altered markedly. Recent scientific cruises have provided new insight into life on areas of the continental shelf that were, but are no longer, under ice shelves. Drilling through ice shelves has revealed life and even colonisation histories in the dark underneath (e.g. Post et al. 2007). Despite this, virtually all of what we know about physical conditions and life on the Antarctic shelf is from the 65% that is not covered by ice shelves, and it is this region that we concentrate on in the current study.

NASA Adv. – GW Hurts Hegemony

Warming destroys the US Navy’s ability to win the artic conflict – facilitates belligerence – on the brink now

MSNBC 11 – [MSNBC, Navy's got new challenges with warming, experts say Report: Arctic role will grow; bases will be vulnerable to storms, rising seas, 3/10/11, <http://www.msnbc.msn.com/id/41990999/ns/us_news-environment/t/navys-got-new-challenges-warming-experts-say/>]

The U.S. Navy should plan for climate change impacts — from costly base repairs, to mobilizing for humanitarian aid and geopolitical conflicts in the Arctic — [the National Research Council said in a report](http://www.nap.edu/catalog.php?record_id=12914) Thursday. "Even the most moderate predicted trends in climate change will present new national security challenges," retired Adm. Frank Bowman, co-chair of the committee that wrote the report at the Navy's request, said in a statement. "Naval forces need to monitor more closely and start preparing now for projected challenges climate change will present in the future," he added. As rising temperatures continue to melt sea ice, Arctic sea lanes could be regularly open across the Arctic by 2030**,** the report noted.The region is already seeing ships testing the waters, as well as nations lining up to seek energy and mineral deposits. Russia has been among the most aggressive in seeking energy riches,while Canada has beefed up its patrols**.** "The geopolitical situation in the Arctic region has become complex and nuanced, despite the area being essentially ignored since the end of the Cold War," the experts wrote. In order to protect U.S. interests, they added, "the Navy should begin Arctic training and the Marine Corps should also reestablish a cold-weather training program. Rising sea levels and more extreme storm surges tied to warming could also become costly for the Navy. A rise of three feet, the experts said, would place at risk 56 Navy installations worth $100 billion. The Navy should expect a rise by 2100 anywhere between a foot and six feet, they added. The report also urged the Navy to increase its capacity for helping climate refugees via hospital ships. "Naval forces must be prepared to provide more aid and disaster relief in the decades ahead," said panel co-chair Antonio Busalacchi, director of the Earth System Science Interdisciplinary Center at the University of Maryland.

Left unchecked, these disputes lead to a US-Russia war

 Zellen, 07- Security Innovator [Barry Zellen, “The Polar Show Down: As the Arctic's ice begins to melt, a new race for its undersea resources begins” August 23, 2007 <http://securityinnovator.com/index.php?articleID=12387&sectionID=43>]

In response to Russia’s aggressive assertion of its claims to the Arctic, Cohen believes that “legal and diplomatic actions are necessary,” and pointed out that the U.S. State Department has “already expressed its skepticism of planting of the Russian Flag,” and believes the act was “not in legal effect.” Cohen added that “Canada joined in this opposition,” noting its Prime Minister, Stephen Harper, quickly embarked upon a “three-day Arctic trip” during which he made major announcements that “increased Canada’s naval presence in the Arctic.” In order to “block Russia's grab,” Cohen believes that the United States “should encourage its friends and allies—especially Canada, Denmark, and Norway—to pursue their own claims with the United Nations Commission on the Limits of the Continental Shelf.” And while America “has not ratified LOST,” the Law of the Sea Treaty, Cohen noted the other Arctic states “have filed claims with the Commission in opposition to Russia's claims,” and believes “the U.S. should also encourage Canada to coordinate a possible claim through the International Justice Court in The Hague against the Russian grab, which the U.S. may join.” Cohen believes Moscow’s “decision to take an aggressive stand has left the U.S., Canada, and the Nordic countries little choice but to forge a cooperative high-north strategy and invite other friendly countries, such as Great Britain, to help build a Western presence in the Arctic: This will probably have to include a fleet of modern icebreakers, submersibles, geophysics/seismic vessels, and polar aircraft.” As Cohen explained, there’s “too much at stake to leave the Arctic to the Russian bear.” But in an optimistic “parting thought,” Cohen added, “I don’t think Russia has financial resources and technology to explore Artic for its riches alone,” and that it “would be much better if U.S., Canada, and—as well as Denmark and Norway will have a multilateral regime negotiated that will specify the economic zones, and will open each other’s resources for joint ventures that will boost economic development in the Arctic.” To understand Russia’s intentions, we interviewed Dr. Vladimir Frolov, the director of the National Laboratory for Foreign Policy, a Moscow-based think tank.[18] Frolov, a former Foreign Service officer, writes about Russia’s foreign policy for Russia Profile magazine and penned a prescient column in the July 17th edition titled “The Coming Conflict in the Arctic: Russia and U.S. to Square Off Over Arctic Energy Reserves.”[19] Frolov explained that “there are two principal lines of thinking on global warming in Russia. One is that global warming is a myth, the other is that global warming exists and it is good for Russia.” He added that “Russia might benefit from global warming if it leads to more mild temperatures in the Arctic, provided the problem of flooding could be solved,” because a milder climate “would make it less prohibitively costly to develop the considerable energy resources that Russia has there.” He noted that “Russia views the Arctic reserves as its ‘last barrel of oil’ to be safeguarded and then used to Russia’s strategic advantage,” much like the U.S. view of “oil exploration in the Arctic National Wildlife Refuge (ANWR).” So bountiful are Russia’s reserves of Arctic petroleum resources that Frolov thinks that they will precipitate an inevitable clash between Russia and the United States reminiscent of its Cold War clash across the Arctic. As Frolov explained in his July 17, 2007 column in Russia Profile, “the stage has been quietly set for a much more serious confrontation in the non-too-distant future between Russia and the United States—along with Canada, Norway and Denmark,” as Russia “recently laid claim to a vast 1,191,000 square km chunk of the ice-covered Arctic seabed.” Its claim is “not really about territory, but rather about the huge hydrocarbon reserves that are hidden on the seabed under the Arctic ice cap: these newly discovered energy reserves will play a crucial role in the global energy balance as the existing reserves of oil and gas are depleted over the next 20 years.”

NASA Adv. – GW Harms Oceans

Even 1 degree of warming warms the oceans and causes catastrophic methane burps

Atcheson 4 – a geologist, has held a variety of policy positions in several federal government agencies. [John Atcheson, “Ticking Time Bomb,” <http://www.commondreams.org/views04/1215-24.htm>]

The Arctic Council's recent report on the effects of global warming in the far north paints a grim picture: global floods, extinction of polar bears and other marine mammals, collapsed fisheries. But it ignored a ticking time bomb buried in the Arctic tundra. There are enormous quantities of naturally occurring greenhouse gasses trapped in ice-like structures in the cold northern muds and at the bottom of the seas. These ices, called clathrates, contain 3,000 times as much methane as is in the atmosphere. Methane is more than 20 times as strong a greenhouse gas as carbon dioxide. Now here's the scary part. A temperature increase of merely a few degrees would cause these gases to volatilize and "burp" into the atmosphere, which would further raise temperatures, which would release yet more methane, heating the Earth and seas further, and so on. There's 400 gigatons of methane locked in the frozen arctic tundra - enough to start this chain reaction - and the kind of warming the Arctic Council predicts is sufficient to melt the clathrates and release these greenhouse gases into the atmosphere. Once triggered, this cycle could result in runaway global warming the likes of which even the most pessimistic doomsayers aren't talking about. An apocalyptic fantasy concocted by hysterical environmentalists? Unfortunately, no. Strong geologic evidence suggests something similar has happened at least twice before. The most recent of these catastrophes occurred about 55 million years ago in what geologists call the Paleocene-Eocene Thermal Maximum (PETM), when methane burps caused rapid warming and massive die-offs, disrupting the climate for more than 100,000 years. The granddaddy of these catastrophes occurred 251 million years ago, at the end of the Permian period, when a series of methane burps came close to wiping out all life on Earth. More than 94 percent of the marine species present in the fossil record disappeared suddenly as oxygen levels plummeted and life teetered on the verge of extinction. Over the ensuing 500,000 years, a few species struggled to gain a foothold in the hostile environment. It took 20 million to 30 million years for even rudimentary coral reefs to re-establish themselves and for forests to regrow. In some areas, it took more than 100 million years for ecosystems to reach their former healthy diversity. Geologist Michael J. Benton lays out the scientific evidence for this epochal tragedy in a recent book, When Life Nearly Died: The Greatest Mass Extinction of All Time. As with the PETM, greenhouse gases, mostly carbon dioxide from increased volcanic activity, warmed the earth and seas enough to release massive amounts of methane from these sensitive clathrates, setting off a runaway greenhouse effect. The cause of all this havoc? In both cases, a temperature increase of about 10.8 degrees Fahrenheit, about the upper range for the average global increase today's models predict can be expected from burning fossil fuels by 2100. But these models could be the tail wagging the dog since they don't add in the effect of burps from warming gas hydrates. Worse, as the Arctic Council found, the highest temperature increases from human greenhouse gas emissions will occur in the arctic regions - an area rich in these unstable clathrates. If we trigger this runaway release of methane, there's no turning back. No do-overs. Once it starts, it's likely to play out all the way. Humans appear to be capable of emitting carbon dioxide in quantities comparable to the volcanic activity that started these chain reactions. According to the U.S. Geological Survey, burning fossil fuels releases more than 150 times the amount of carbon dioxide emitted by volcanoes - the equivalent of nearly 17,000 additional volcanoes the size of Hawaii's Kilauea. And that is the time bomb the Arctic Council ignored. How likely is it that humans will cause methane burps by burning fossil fuels? No one knows. But it is somewhere between possible and likely at this point, and it becomes more likely with each passing year that we fail to act. So forget rising sea levels, melting ice caps, more intense storms, more floods, destruction of habitats and the extinction of polar bears. Forget warnings that global warming might turn some of the world's major agricultural areas into deserts and increase the range of tropical diseases, even though this is the stuff we're pretty sure will happen. Instead, let's just get with the Bush administration's policy of pre-emption. We can't afford to have the first sign of a failed energy policy be the mass extinction of life on Earth**.**

 Oceanic bursts are more powerful than a nuclear war

Ryskin, ‘3- NU Chemical Engineer [Gregory Ryskin, Department of Chemical Engineering, Northwestern University, Illinois, “Methane-driven oceanic eruptions and mass extinctions” Geology 31(9): 741-744]

Upon release of a significant portion of the dissolved methane, the ocean settles down, and the entire sequence of events (i.e., development of anoxia, accumulation of dissolved methane, the metastable state, eruption) begins anew. No external cause is required to bring about a methane-driven eruption—its mechanism is self-contained, and implies that eruptions are likely to occur repeatedly at the same location. Because methane is isotopically light, its fast release must result in a negative carbon isotope excursion in the geological record. Knowing the magnitude of the excursion, one can estimate the amount of methane that could have produced it. Such calculations (prompted by the methane-hydrate-dissociation model, but equally applicable here) have been performed for several global events in the geological record; the results range from ;1018 to 1019 g of released methane (e.g., Katz et al., 1999; Kennedy et al., 2001; de Wit et al., 2002). These are very large amounts: the total carbon content of today’s terrestrial biomass is ;2 3 1018 g. Nevertheless, relatively small regions of the deep ocean could contain such amounts of dissolved methane; e.g., the Black Sea alone (volume ;0.4 3 1023 of the ocean total; maximum depth only 2.2 km) could hold, at saturation, ;0.5 3 1018 g. A similar region of the deep ocean could contain much more (the amount grows quadratically with depth3). Released in a geological instant (weeks, perhaps), 1018 to 1019 g of methane could destroy the terrestrial life almost entirely**.** Combustion and explosion of 0.75 3 1019 g of methane would liberate energy equivalent to 108 Mt of TNT, ;10,000 times greater than the world’s stockpile of nuclear weapons, implicated in the nuclear winter scenario **(**Turco et al., 1991).

NASA Adv. – GW 🡪 War

Global warming leads to mass and unending international conflict

Klare 6 – Professor of Peace and World Security Studies [Michael Klare, professor of peace and world security studies at Hampshire College, The Coming Resource Wars, 3-10-2006, http://www.alternet.org/environment/33243]

It's official: the era of resource wars is upon us. In a major London address, British Defense Secretary John Reid warned that global climate change and dwindling natural resources are combining to increase the likelihood of violent conflict over land, water and energy. Climate change, he indicated, "will make scarce resources, clean water, viable agricultural land even scarcer" -- and this will "make the emergence of violent conflict more rather than less likely." Although not unprecedented, Reid's prediction of an upsurge in resource conflict is significant both because of his senior rank and the vehemence of his remarks. "The blunt truth is that the lack of water and agricultural land is a significant contributory factor to the tragic conflict we see unfolding in Darfur," he declared. "We should see this as a warning sign." Resource conflicts of this type are most likely to arise in the developing world, Reid indicated, but the more advanced and affluent countries are not likely to be spared the damaging and destabilizing effects of global climate change. With sea levels rising, water and energy becoming increasingly scarce and prime agricultural lands turning into deserts, internecine warfare over access to vital resources will become a global phenomenon. Reid's speech, delivered at the prestigious Chatham House in London (Britain's equivalent of the Council on Foreign Relations), is but the most recent expression of a growing trend in strategic circles to view environmental and resource effects -- rather than political orientation and ideology -- as the most potent source of armed conflict in the decades to come. With the world population rising, global consumption rates soaring, energy supplies rapidly disappearing and climate change eradicating valuable farmland, the stage is being set for persistent and worldwide struggles over vital resources. Religious and political strife will not disappear in this scenario, but rather will be channeled into contests over valuable sources of water, food and energy. Prior to Reid's address, the most significant expression of this outlook was a report prepared for the U.S. Department of Defense by a California-based consulting firm in October 2003. Entitled "An Abrupt Climate Change Scenario and Its Implications for United States National Security," the report warned that global climate change is more likely to result in sudden, cataclysmic environmental events than a gradual (and therefore manageable) rise in average temperatures. Such events could include a substantial increase in global sea levels, intense storms and hurricanes and continent-wide "dust bowl" effects. This would trigger pitched battles between the survivors of these effects for access to food, water, habitable land and energy supplies."Violence and disruption stemming from the stresses created by abrupt changes in the climate pose a different type of threat to national security than we are accustomed to today," the 2003 report noted. "Military confrontation may be triggered by a desperate need for natural resources such as energy, food and water rather than by conflicts over ideology, religion or national honor." Until now, this mode of analysis has failed to command the attention of top American and British policymakers. For the most part, they insist that ideological and religious differences -- notably, the clash between values of tolerance and democracy on one hand and extremist forms of Islam on the other -- remain the main drivers of international conflict. But Reid's speech at Chatham House suggests that a major shift in strategic thinking may be under way. Environmental perils may soon dominate the world security agenda. This shift is due in part to the growing weight of evidence pointing to a significant human role in altering the planet's basic climate systems. Recent studies showing the rapid shrinkage of the polar ice caps, the accelerated melting of North American glaciers, the increased frequency of severe hurricanes and a number of other such effects all suggest that dramatic and potentially harmful changes to the global climate have begun to occur. More importantly, they conclude that human behavior -- most importantly, the burning of fossil fuels in factories, power plants, and motor vehicles -- is the most likely cause of these changes. This assessment may not have yet penetrated the White House and other bastions of head-in-the-sand thinking, but it is clearly gaining ground among scientists and thoughtful analysts around the world. For the most part, public discussion of global climate change has tended to describe its effects as an environmental problem -- as a threat to safe water, arable soil, temperate forests, certain species and so on. And, of course, climate change is a potent threat to the environment; in fact, the greatest threat imaginable. But viewing climate change as an environmental problem fails to do justice to the magnitude of the peril it poses. As Reid's speech and the 2003 Pentagon study make clear, the greatest danger posed by global climate change is not the degradation of ecosystems per se, but rather the disintegration of entire human societies, producing wholesale starvation, mass migrations and recurring conflict over resources. "As famine, disease, and weather-related disasters strike due to abrupt climate change," the Pentagon report notes, "many countries' needs will exceed their carrying capacity" -- that is, their ability to provide the minimum requirements for human survival. This "will create a sense of desperation, which is likely to lead to offensive aggression" against countries with a greater stock of vital resources. "Imagine eastern European countries, struggling to feed their populations with a falling supply of food, water, and energy, eyeing Russia, whose population is already in decline, for access to its grain, minerals, and energy supply." Similar scenarios will be replicated all across the planet, as those without the means to survival invade or migrate to those with greater abundance -- producing endless struggles between resource "haves" and "have-nots." It is this prospect, more than anything, that worries John Reid. In particular, he expressed concern over the inadequate capacity of poor and unstable countries to cope with the effects of climate change, and the resulting risk of state collapse, civil war and mass migration. "More than 300 million people in Africa currently lack access to safe water," he observed, and "climate change will worsen this dire situation" -- provoking more wars like Darfur. And even if these social disasters will occur primarily in the developing world, the wealthier countries will also be caught up in them, whether by participating in peacekeeping and humanitarian aid operations, by fending off unwanted migrants or by fighting for access to overseas supplies of food, oil, and minerals. When reading of these nightmarish scenarios, it is easy to conjure up images of desperate, starving people killing one another with knives, staves and clubs -- as was certainly often the case in the past, and could easily prove to be so again. But these scenarios also envision the use of more deadly weapons. "In this world of warring states," the 2003 Pentagon report predicted, "nuclear arms proliferation is inevitable." As oil and natural gas disappears, more and more countries will rely on nuclear power to meet their energy needs -- and this "will accelerate nuclear proliferation as countries develop enrichment and reprocessing capabilities to ensure their national security." Although speculative, these reports make one thing clear: when thinking about the calamitous effects of global climate change, we must emphasize its social and political consequences as much as its purely environmental effects. Drought, flooding and storms can kill us, and surely will -- but so will wars among the survivors of these catastrophes over what remains of food, water and shelter. As Reid's comments indicate, no society, however affluent, will escape involvement in these forms of conflict.

Global warming leads to conflict in all major hotpots

McGinn 10 – Fellow in Strategic Studies @ Naval War College Dennis McGinn, senior policy advisor to the American Council on Renewable Energy and is an international security senior fellow at the Rocky Mountain Institute, previously served as chairman of the U.S. Naval Institute Board of Directors, 12-1-2010, “ENERGY CHALLENGES; COMMITTEE: HOUSE SELECT ENERGY INDEPENDENCE AND GLOBAL WARMING,” CQ Congressional Testimony, Lexis]

Last year, global climate researchers revised those predictions, now forecasting that the planet could warm by as much as 6.3 degrees Fahrenheit by the end of the century even if the world's leaders fulfill their most ambitious climate pledges, a much faster and broader scale pace of change than the IPCC forecast just two years ago. Their other findings include that sea level could rise by as much as six feet by 2100 instead of 1.5 feet, as the IPCC had projected, and the Arctic Sea may experience an ice-free summer by 2030, rather than by the end of the century. Let me give you some examples, from a military perspective, of what the future could be like if we fail to adequately address the causes and effects of climate change. In Africa, projected rising temperatures will dramatically reduce water availability, soil moisture, arable land and food production. Combined with increased extreme weather events - climate impacts will act to accelerate the destabilization of populations and governments already dealing with more traditional causes of conflict. Climate-driven crises are already happening there. Lack of water and changing agricultural patterns are at the root of crises in Darfur and Somalia, present day examples of failed social structures and governments, leading to widespread humanitarian crises, conflict, piracy and terrorism. In South and Central America - melting glaciers in Venezuela and the Peruvian Andes will directly impact water supplies and hydroelectric power. The Peruvian plains, northeast Brazil and Mexico will experience longer and more serious droughts. Land degradation and loss of food production will hit hard in Latin America - particularly Brazil whose economy is fueled by food exports - possibly leading to social disruptions and significant migration. We need only reflect on present immigration and security challenges along the U.S. southern border to get a glimpse of what the future could hold: immigration driven not by a search for a better economic life but in search of basic needs. In Bangladesh, the growing threat of more frequent and intense typhoons in the Bay of Bengal has the potential for wiping out essential coastal agriculture and fishing areas, just as it did in 1991 resulting in the U.S. military led Operation Sea Angel. Greater and more prolonged coastal typhoon damage would create an unprecedented humanitarian crisis, which could drive literally millions of refugees northwest toward India in search of relief. As the Himalayan glaciers recede, Asian nations like China, India and Pakistan will have to deal with internal and external unrest due to a much less reliable source of water from four great rivers --- creating floods at some times of the year, prolonged drought during others-- to meet the needs of growing populations. This past summer, we saw massive flooding in Pakistan that continues to affect more than twenty million people in a nuclear- armed nation, with an ongoing extremist insurgency that has direct bearing on the outcome of allied operations in Afghanistan. 40 percent of Asia's four billion people live within 45 miles of the coast - with coastlines and infrastructure that could be inundated by rising seas. Even the most modest projections of increased temperature and sea level rise include widespread flooding and loss of significant percentages of coastal delta farmland and heavily populated areas. In the Middle East, the vast majority of highly diverse populations already depend on water sources external to their borders. A greatly increased competition for diminishing supplies of water for agriculture and basic human needs would significantly ratchet up tensions in this historically critical and politically unstable region. These potential climate change effects will not just create crisis events happening far away from American soil or along our borders. Disasters like Hurricane Katrina in 2005 reveal, in a very stark way, how a natural disaster-caused humanitarian crisis can quickly lead to suffering, civil unrest and the need for a massive, expensive and sustained mobilization of resources. In fact today, more than five years after Hurricane Katrina produced widespread destruction along the Gulf Coast, thousands of people have not returned to their homes and hundreds of millions of dollars in damaged infrastructure remain. As CNA Military Advisory Board member Vice Admiral Richard Truly said climate change is not like "some hot spot we're trying to handle." "It's going to happen to every country and every person in the whole world at the same time." ii And while the effects of global warming create this potential environmental havoc, its principal dynamic will be to shift the world's balance of power and money.iii Drought and scant water supply have already fueled civil conflicts in global hot spots like Afghanistan, Nepal and Sudan, according to several new studies. The evidence is fairly clear that sharp downward deviations from normal rainfall in fragile societies elevate the risk of major conflict.iv Climate impacts like extreme drought, flooding, storm, temperatures, sea level rise, ocean acidification, and wildfires - occurring more frequently and more intensely across the globe - - will inevitably create political instability where societal demands for the essentials of life exceed the capacity of governments to cope. As noted above, fragile governments will become failed states, and desperation and hopelessness will drive whole populations to be displaced on a scale far beyond what we see today. And into this turmoil and power vacuum will rush paramilitaries, organized crime, extremists producing a highly exportable brand of terrorism.

Global warming leads to nuclear war

Dyer 9 – PhD in ME History [Gwynne Dyer, MA in Military History and PhD in Middle Eastern History former @ Senior Lecturer in War Studies at the Royal Military Academy Sandhurst, Climate Wars]

THIS BOOK IS AN ATTEMPT, peering through a glass darkly, to understand the politics and the strategies of the potentially apocalyptic crisis that looks set to occupy most of the twenty­first century. There are now many books available that deal with the science of climate change and some that suggest pos­sible approaches to getting the problem under control, but there are few that venture very far into the grim detail of how real countries experiencing very different and, in some cases, overwhelming pressures as global warming proceeds, are likely to respond to the changes. Yet we all know that it's mostly politics, national and international, that will decide the outcomes. Two things in particular persuaded me that it was time to write this book. One was the realization that the first and most important impact of climate change on human civiliza­tion will bean acute and permanent crisis of food supply. Eating regularly is a non-negotiable activity, and countries that cannot feed their people are unlikely to be "reasonable" about it. Not all of them will be in what we used to call the "Third World" -the developing countries of Asia, Africa and Latin America. The other thing that finally got the donkey's attention was a dawning awareness that, in a number of the great pow­ers, climate change scenarios are already playing a large and increasing role in the military planning process. Rationally, you would expect this to be the case, because each country pays its professional military establishment to identify and counter "threats" to its security, but the implications of their scenarios are still alarming. There is a probability of wars, including even **nuclear wars**, if temperatures rise two to three degrees Celsius. Once that happens, all hope of international cooperation to curb emissions and stop the warming goes out the window.

NASA Adv. – High Launch Costs Prevent NASA

Cheaper access to space is key to continuous climate data-collection

Campbell, ’11 --Lt. Gen., USAF (Ret.), [John H. Campbell, Now Launching: Public-Private Partnerships That Ensure Our Future in Space, 3/29/11, http://www.hostedpayload.com/blog/now-launching-public-private-partnerships-that-ensure-our-future-in-space]

With one of our highest-profile NASA programs winding down, it’s a good time to ask what leadership in space in the future looks like – not just for manned flights, but for less celebrated missions that could address other pressing requirements such as monitoring the increased number of objects in space for enhanced space situational awareness; understanding the effects of the upper atmosphere on Earth; terrestrial weather and climate control; and monitoring of aeronautical traffic, not just over land but over oceans and remote areas. Access to space is expensive: NASA estimates a price tag of $450 million for a space shuttle mission, and unmanned missions are expensive too. Less expensive access to space is important to the future of the U.S. space program. Consider, for example, space-based data collection missions to build a comprehensive picture of the effects of climate change. Many organizations involved in global warming research -- such as NASA, the National Oceanic and Atmospheric Administration (NOAA), the National Science Foundation (NSF), and various international space agencies -- may require continuity and even expansion of space-based data collection. The good news is that the private sector is offering affordable access to space – and the pace is accelerating as a result of President Obama’s National Space Policy unveiled in 2010. The new National Space Policy provides a logical way forward. Among its many initiatives, it emphasizes the importance of using commercial capabilities and services, and exploring non-traditional arrangements to meet U.S. government requirements. Public-private partnerships to “host” government capabilities aboard commercial spacecraft are one specific measure called out in the Policy. Simply put, hosted payloads present an opportunity for the U.S. Government to leverage commercial investments to provide access to space at significant savings over the cost of traditional dedicated missions. Indeed, it is far less expensive for the government to get into space with a partner than it is to go it alone. Hosted missions are estimated to cost about one-quarter of dedicated missions, according to Bethesda, Md.-based Futron, a leading aerospace consulting firm. Further, by sharing launch costs with the private sector, the Policy initiatives may help free up funds for NASA to focus on myriad other space projects such as going to Mars, where the government, not private enterprise, holds the advantage.

Lower launch costs improve environmental monitoring capabilities

Collins and Autino, ‘9 -- Life & Environmental Science, Azabu University, Japan, and Andromeda Inc., Italy [Patrick Collins\* & Adriano Autino\*\*, What the Growth of a Space Tourism Industry Could Contribute to Employment, Economic Growth, Environmental Protection, Education, Culture and World Peace, Originally presented at Plenary Session of the International Academy of Astronautics' 1st Symposium on Private Human Access to Space, held at Arcachon in France, 25-28 May 2008. Revised and updated 11 June 2009, http://www.spacefuture.com/archive/what\_the\_growth\_of\_a\_space\_tourism\_industry\_could\_contribute\_to\_employment\_economic\_growth\_environmental\_protection\_education\_culture\_and\_world\_peace.shtml]

Economic development in space based on low launch costs could contribute greatly, even definitively, to solving world environmental problems. As a first step, substantially reducing the cost of space travel will reduce the cost of environment-monitoring satellites, thereby improving climate research and environmental policy-making.

Recent cuts leaves NASA with no heavy lift vehicles to launch its climate satellites—Current contracts are pricing the program out of existence

Clark, ‘11 [Stephen Clark, Rising launch costs could curtail NASA science missions,” Space Flight Now, 4/4/11, http://spaceflightnow.com/news/n1104/04launchcosts/]

NASA uses a fleet of launch vehicles to deploy satellites. The agency often selects the United Launch Alliance Atlas 5 booster to launch solar system missions and large climate research spacecraft. But the Atlas 5 is overkill for many small and medium-class NASA spacecraft, unnecessarily raising the overall cost of missions. The phasing out of the smaller and less expensive Delta 2 rocket leaves NASA with no other proven launch vehicles for those probes. The last Atlas launcher chosen by NASA was for the MAVEN mission to Mars scheduled to lift off in November 2013. The $187 million contract was announced in October and provides for launch on an Atlas 5-401 booster, the rocket's most basic configuration with no solid rocket boosters, a 4-meter payload fairing and a single-engine Centaur upper stage. Three years before NASA announced the MAVEN launch contract, the space agency signed a deal to lift the next Landsat remote sensing satellite on the same version of the Atlas 5 rocket for $124 million. Lynn Cline, deputy associate administrator for NASA's space operations mission directorate, told an agency advisory panel last month the cost of the Atlas 5-401 is expected to rise by 17 percent over MAVEN's $187 million contract value for launches in 2016 and 30 percent for missions in 2018. The problem is so severe that Michael Freilich, director of NASA's Earth science division, has urged climate research projects to design their spacecraft to fit on smaller rockets than the Atlas 5 and pretend as if larger boosters don't exist in the United States, he told the NASA Advisory Council's science committee in March. The skyrocketing launch costs are part of the NASA Launch Services contract signed last year. The NLS agreement with four companies, which follows up a similar expiring contract, covers rocket flight opportunities for NASA spacecraft over the next 10 years. A previous NLS contract expired last year and held provisions for heavily discounted rocket costs due to projections of a more robust U.S. commercial launch services market when it was signed in 2000. "The expectation at that time was there was a large commercial market," Cline said. "That did not materialize. As opposed to government being a secondary customer buying on the margin, government became the primary customer." With government as the anchor customer, marginal launch costs for NASA and the Air Force are on the rise. "Rocket costs are going crazy and mostly up," said Steve Squyres, a respected planetary scientist and chair of a panel of researchers that issued recommendations in March for NASA to address the possibility of a declining budget matched against rising launch prices. Squyres led the National Research Council's planetary science decadal survey, an independent report ranking a slate of robotic solar system missions for the next 10 years. "Launch vehicle costs are high," Squyres said. "They're growing. They're growing in a somewhat volatile and unpreditable fashion. They're becoming an increasingly large fraction of the cost of planetary missions, which is a trend we view with some alarm.

NASA Adv. – AT: NASA Doesn’t Solve Warming

NASA Earth Science solves Global Warming—leads to corrections in climate science and better climate programs

NAST 8 – non profit dedicated to restoring emphasis on science, aeronautics, and human exploration ( “NASA’S ROLE IN THE 21ST CENTURY “Fall 2008, http://nastus.org/documents/NASARole.21stCentury.pdf)

2) Monitoring and predicting climate change and the impact of mitigation strategies Climate change is likely to be a dominating global issue for the rest of this century. NASA’s Earth science program is already the global leader in the measurement and prediction of climate change. The focus of climate change science/studies is now shifting to better prediction of its evolution and impacts, and developing and monitoring effective mitigation strategies. NASA must next be challenged with dramatically improving its climate prediction capability as well as taking on the new challenge of accurately predicting the impacts of climate change on our civilization and the biosphere. Additionally, there are already many speculative proposals for climate change mitigation strategies which attempt to introduce climate forcing that acts opposite to the greenhouse effect or which attempt to capture or reduce existing greenhouse gases. Given the complex feedbacks in the climate system, understanding the possible unintended consequences of such mitigation strategies will become more important.

NASA is key to federal government efforts to combat global warming.

Stempeck 5 – E&E Daily senior reporter

[Brian Stempeck, “CLIMATE CHANGE: NASA space missions may undermine climate studies,” April 29, Environment and Energy Daily, Lexis]

Currently, NASA contributes about 60 percent of the funding to the Climate Change Science Program, the umbrella group that directs the administration's efforts to study global warming. NASA satellites measure sea level rise, for example, and also take suborbital measurements of air quality, according to Alphonso Diaz, associate administrator with the agency. There have already been some negative effects on climate change research, experts said. In 2004, agency officials proposed accelerating the NASA Glory mission, which tracks how aerosols in the atmosphere affect global warming. "NASA is now proposing cancellation of the mission," said Timothy Killeen, director of the National Center for Atmospheric Research. Aerosols -- which include soot from diesel engines, wood-burning stoves and wildfires -- are a major unanswered question in the climate field. While scientists have largely reached consensus about how greenhouse gases like carbon dioxide and methane affect global temperatures, they are less sure about the effect of particulate matter. Killeen tried to put the NASA funding in perspective for committee members. "In sheer budgetary terms, NASA is the single largest environmental science program supported by the federal government," he told lawmakers. The agency provided 34 percent of all federal environmental science funding in 2004 and has been making solid contributions in the field for decades. A NASA satellite recently began tracking carbon monoxide air pollution as it migrates from one country to another around the globe, Killeen noted, showing that "California's air quality is influenced by industrial activity in Asia." "Without NASA's commitment to innovation in the earth sciences, it is hard to believe that such an incredible new capability would be available today," Killeen said.

NASA satellites key to combatting climate change.—But budget constraints put them at risk of cuts

Huetteman 11 - Writer for the Washing ton Post

[Emmarie Huetteman, January 25, Washington Post, “Scientists' hopes for climate data are up in the air,” Lexis]

Shortly after it lifted off in February 2009, NASA's Orbiting Carbon Observatory crashed into the Pacific Ocean near Antarctica. With that, a $250 million investment became scrap metal on the ocean floor and an effort to begin using satellites to measure atmospheric carbon dioxide and trace emission-reduction actions was dealt a huge setback. Scientists say the information the OCO was intended to collect is a crucial piece of the data needed not only by those monitoring the Earth's environment but also by federal officials struggling to understand possible national security implications of those climate changes. But the OCO's failure highlighted an even broader problem: Understanding climate change requires a breadth of information on variables from atmospheric carbon dioxide to the condition of Arctic ice, and scientists say that satellites are vital for this. Yet at a time where the massive Larsen B Ice Shelf in Antarctica seems intact one day and then collapses into the sea the next, the system of continuous, reliable satellite observation of Earth is at risk, with some aging satellites in dire need of replacement. The OCO was "the only satellite in the world that will do the kind of global collection we need," said James Lewis, a senior fellow at the Center for Strategic and International Studies and one of the authors of a 2010 report on satellite monitoring of climate change. "And we haven't thought about how to replace it." Berrien Moore III, an earth scientist who co-chaired a National Research Council committee several years ago on space-based observation of Earth, said climate change predictions based on mathematical models have failed to capture how quickly sea ice would decline. "Thank God for the [satellite] observations, because otherwise we wouldn't have known this is going on," said Moore, vice president for weather and climate programs at the University of Oklahoma. A 2005 report by the National Research Council sounded the alarm about the climate satellite system, declaring it was "at risk of collapse," largely because of weakening of U.S. financial support for such programs. The 2010 report by Lewis and others asserted that half of all climate satellites will have outlived their design life within the next eight years. NASA's earth science budget shrank from about $2 billion to $1.4 billion between 2000 and 2006, when the Bush administration's greater funding priority was space exploration. Several environment-related satellite missions were either cut or shelved.

NASA climate monitoring produces best solutions to warming

Daily Press, 4/13/11, lexis

April 13--In 2007, NASA was tasked with improving the accuracy of computer models used to predict climate change. The agency spent tens of millions of dollars developing a program, dubbed CLARREO, until it fell victim to budget cuts proposed by President Barack Obama in February. Its sudden cancelation surprised NASA scientists, who are considering a short list of options, including partnering with foreign space agencies, to save to the program. Meanwhile, environmental activists and climate scientists worry the U.S., after failing to address climate change in energy legislation, is delaying action on an issue that will grow more urgent. "I'm very pessimistic that it'll get funded," said Douglas Dwoyer, a retired administrator at NASA Langley Research Center in Hampton, where CLARREO is based. NASA relies on a patchwork of satellites and instruments -- many developed decades ago for other purposes -- to measure Earth's climate system. For example, one satellite monitors ice sheets while another tracks soil moisture. CLARREO, which stands for Climate Absolute Radiance and Refractivity Observatory, would measure the entire climate system. That includes the energy that Earth emits to space, such as water vapor and carbon dioxide, and the sunlight Earth reflects back to space. "The combination of the two is really what drives the Earth's climate system," Langley scientist Bruce Wielicki said on a NASA produced video. CLARREO also would measure temperature changes in the lower part of Earth's atmosphere, he said. The $1.1 billion program, which was scheduled to launch in 2017, would gather the most accurate climate data ever, he said. It could help policymakers worldwide better respond to global warming and, possibly, silence skeptics who doubt that mankind is causing Earth's temperature to rise. "Well, CLARREO's benefit to the public actually is very direct," said Wielicki, a member of the Intergovernmental Panel on Climate Change, which shared a Nobel Peace Prize in 2007 with former Vice President Al Gore.

NASA Adv. – AT: NASA Sufficiently Funded

Funding cuts threaten NASA’s ability to monitor climate

Kaufman 7 - Staff writer at the Washington Post (Marc, “Cutbacks Impede Climate Studies; U.S. Earth Programs In Peril, Panel Finds” January 16, Lexis)

The government's ability to understand and predict hurricanes, drought and climate changes of all kinds is in danger because of deep cuts facing many Earth satellite programs and major delays in launching some of its most important new instruments, a panel of experts has concluded. The two-year study by the National Academy of Sciences, released yesterday, determined that NASA's earth science budget has declined 30 percent since 2000. It stands to fall further as funding shifts to plans for a manned mission to the moon and Mars. The National Oceanic and Atmospheric Administration, meanwhile, has experienced enormous cost overruns and schedule delays with its premier weather and climate mission. As a result, the panel said, the United States will not have the scientific information it needs in the years ahead to analyze severe storms and changes in Earth's climate unless programs are restored and funding made available. "NASA's budget has taken a major hit at the same time that NOAA's program has fallen off the rails," said panel co-chairman Berrien Moore III of the University of New Hampshire. "This combination is very, very disturbing, and it's coming at the very time that we need the information most."

NASA Adv. – Satellites Key – Solve Warming

Satellites key to climate monitoring—More satellites mean more systematic information

Norris, ’10 – Chairman of the RAeS Space Group [Pat Norris, Watching Earth from Space: How Surveillance Helps Us - And Harms Us, August 2010, p. 261]

Some people say that we wouldn't know about climate change were it not for satellites. Satellites certainly document changes in climate and related topics on a global scale. However, the key measurement for climate change was the carbon dioxide record in the ice dug out in Greenland or measured in weather stations on top of mountains in Hawaii. The amount of carbon dioxide in the air has been growing steadily since the start of the industrial revolution 250 years ago, and it shows no signs of letting up. The rising world temperature triggered by that carbon dioxide has many uncomfortable repercussions, such as melting glaciers, rising sea levels and changes in rainfall patterns. Satellites are central to our ability to monitor these problems worldwide. The ingenuity of space engineers now allows us to watch at night and through clouds. Satellites are good at watching other important changes such as the spread of deserts or the shrinking of lakes - they capture the big picture that can then be documented in detail on the ground. They are also objective, as when monitoring the area of land being farmed in a totalitarian state that otherwise tends to invent the statistics to suit the propaganda line. These climate-related and man-made changes will continue to be important for the foreseeable future. Indeed, as the world's population inexorably grows (6 billion, rising towards 9 billion by the year 2100), these problems will surely intensify. Satellites will therefore be even more important in keeping us informed about the state of the world. Increasing population means increasing pressure on the world's resources. This is clearly true for non-renewable resources such as oil and gas, minerals, topsoil and fossil aquifers. It is also true for normally replaceable resources such as fresh water and fish as they are exploited beyond their ability to recover. Satellites can often monitor these resources, but countries have to want to address the situation for it to improve. So, the future will certainly include more and different types of surveillance satellites as the world watches us destroy the environment we live in. Or perhaps the sight of the shrinking forests and expanding deserts will trigger an era of constructive collaboration between countries to husband the resources we have. There will be more of the fleets of smallish satellites (weighing a ton or less) that provide frequent updates on what's happening. The information needed to predict climate change will be collected more systematically than now.

NASA Adv. – Satellites Key –Sea Level

Key to measuring sea level

Norris, ’10 – Chairman of the RAeS Space Group [Pat Norris, Watching Earth from Space: How Surveillance Helps Us - And Harms Us, August 2010, p. 47-8]

Take sea level, for example. Global warming is thought to raise sea level by a few millimeters per year - 2 mm/year in the 20th century has risen to currently 3 mm/ year now.2 But, each day, even the calmest sea rises and falls by meters because of the tides (except inland seas, such as the Mediterranean, which are less affected by tides). It is not easy to spot changes of millimeters when the effects of tides (and waves) swamp the measurement; the only way is to gather measurements over many years so that the accumulation of "a few millimeters" will become noticeable against the daily tidal ups and downs. If you measure over many years, you have to watch out that the tide gauge (as the measuring instrument is called) doesn't sink slightly as land often does on the coast - a sinking tide gauge will appear to measure a rising sea level. Land rises in some parts of the world, such as in Scandinavia and Canada, as the earth gradually recovers ("rebounds" as the scientists say) from the huge mass of glaciers that covered it during the last ice age. A rising tide gauge will appear to measure a falling sea level. Scientists estimate the amount of rise or fall of the land at each tide gauge and remove that from the sea level figures. You also have to take these measurements across the globe. Tide gauges are inevitably constrained to be on land, so sea level in vast areas of open ocean goes unmonitored. Satellites can address this issue. The idea is to have an altimeter on the satellite that measures the distance from the satellite to the ground below. If you know the trajectory of the satellite precisely, then you can work out the altitude of the ground below. The key here is that you know the satellite trajectory from Newton's laws, the same laws that allow us to predict eclipses of the sun and moon. Over Mount Everest in the Himalayas, the satellite altimeter will show that the distance to the ground is 8.8 km (29,000 ft) shorter than when over the ocean. Over the ocean, the altimeter measures the distance to the sea below which can be averaged to smooth out the effects of waves. Satellites circle the globe, so, day after day, year after year, a satellite altimeter measures how far below the satellite the sea surface is. Figure 22 shows the results from satellites developed by the USA and Europe - TOPEX/Poseidon until 2002, the Jason series thereafter. Sea level is shown as currently rising at more than 3 mm/year averaged across the globe. A global average hides a lot of regional variation. Figure 23 shows the sea level changes for the same period as Figure 22 but on a regional basis. In some areas, sea level is rising at 10 mm/year while in others it is falling at 10 mm/year. The rises outweigh the falls, thus giving the global average rise of 31. mm/year. A satellite altimeter has another big advantage over tide gauges in that just one instrument measures sea level over the whole world. It takes thousands of tide gauges to get close to this and it is difficult to ensure that all of the gauges are accurate. One of the big challenges with a satellite altimeter is to know the satellite's trajectory with an accuracy of a millimeter or better. The best way to check this is to look at the altimeter reading over a fixed point on the earth in two successive passes by the satellite. If the altimeter readings differ by a few millimeters at one of these "crossover points", then our assumption about the trajectory is modified to remove the difference. With information from lots of these crossover points plus tracking data from radars and lasers around the world, the satellite trajectory is computed with the required accuracy.3 The importance of monitoring sea level has increased as we discover that it could change much more rapidly than the 3 Y4 mm/year mentioned above. A recent report found that sea level during the recent ice ages went up and down as much as 2 m in a century, which averages out as 20 mm/year or six times faster than the current value. 4

NASA Adv. – Satellites Key – Temp Data

Key to best temperature data—New satellite tech is just being created

Norris, ’10 – Chairman of the RAeS Space Group [Pat Norris, Watching Earth from Space: How Surveillance Helps Us - And Harms Us, August 2010, p. 50-53]

By and large, temperature varies by tens of degrees from day to night, from one day to the next, and from summer to winter. Thus, the first reaction to being warned of a 1°C rise in temperature is likely to be a yawn. A graph of the average temperature across the globe for the past ISO years is shown in Figure 24 and indicates that the temperature has risen by somewhat less than I °C since 1860. The Inter-governmental Panel on Climate Change (IPCC) is the most authoritative source of climate information. According to the IPCC, global temperature is currently rising at one- sixth of a degree per decade, which, if it were to continue at this rate, would mean a rise of 1.77°C in the next 100 years.6 In fact, temperatures are expected to rise faster than the present trend and to have gone up by perhaps 3 or 4°C, depending on how much carbon dioxide we continue to pump into the sky.7 Scientists illustrate the importance of a 1°C temperature rise by pointing out that today's temperature differs from that at the height of the last ice age by perhaps only 4c C.8 So, if a 4C C rise in temperature can move the earth from deep ice age to the current norm, what changes could a few degrees more warming cause? A temperature rise in the middle of the Sahara desert probably won't have much effect - the land is already uninhabitable. But if higher temperatures melted the snow in Tibet, a billion people in China, India, Pakistan, Bangladesh and neighboring countries would lose their fresh water. Glaciers in Tibet are considered to be the world's third "pole" after the Antarctic and Arctic regions. Melting snow from the Himalayas and the Tibetan plateau feeds major rivers such as the Yellow and Yangtze in China, the Mekong in Vietnam and Cambodia, the Ganges in India and Bangladesh and the Indus in Pakistan. Recent reports have suggested that the Tibetan glaciers are retreating and disappearing fast, threatening the life-giving water supply for much of South and East Asia. The speed of the glaciers' retreat is a matter of controversy - hence the urgency of getting reliable information. As so often nowadays, it's not clear whether a recent drought in southwest China (the region nearest to the Himalayas) is due to climate change or is just another in the long series of droughts that affects China from time to time. Reported to be the worst drought to hit China in a century, it has not only left millions of people and livestock without adequate drinking water, but it has also caused electricity "brownouts" due to the reduction in hydroelectric power. Some rationing of power to factories has had to be introduced. About 15% of China's electricity is hydroelectric, making it the world's largest producer of this form of "sustainable" energy, and the amount is due to double by 2020. Rapid development across China has caused deforestation, which, in turn, has reduced groundwater in the southwest. The result will be increased use of coal-fired power stations, already the source of 80% of China's electricity, the cause of much of its air pollution and the source of vast quantities of climate-impacting greenhouse gases.9 Figure 25 illustrates how satellites can monitor glaciers in the Himalayas. The growth of lakes on the glaciers is a sign that the glaciers are melting and is readily monitored by satellite. Glaciers in the Andes are also retreating and have lost 20% of their volume since 1975, sometimes with devastating consequences. A piece of the Hualcan glacier fell into a lake in Peru in April 2010, causing a massive wave that swept away houses and factories, killing at least one fisherman. The governor of the region, Cesar Alvarez, blamed climate change. "Because of global warming the glaciers are going to detach and fall on these overflowing lakes," he said. 10 Measuring global temperature has proved to be difficult and controversial and satellites are only just beginning to help. One difficulty is ensuring that the thermometers don't change over periods of several decades. If it's in a laboratory, you can check it against melting ice and boiling water (0 and lOO°C, respectively, by definition), but that's more difficult to do on a mountain top or in a remote valley. One of the problems identified only recently is that cities and towns are hotter than the countryside due to the heat given off by us humans and our activities. Figure 26 shows this vividly in the form of a satellite image of the town and city lights of the USA that illustrate the heat being generated by our urban society. The answer has been to treat with caution temperatures taken in the past by urban thermometers and to move them all to rural sites. There is also that tricky problem of taking measurements in the middle of the ocean and on top of glaciers. In the past, sailors would toss a bucket over the side of the ship to bring up some water and stick a thermometer into the water. In recent years, it was recognized that wooden buckets give a different temperature from metal or canvas ones, and both give different temperatures from that measured at the inlet for engine room cooling water - this last is the method currently favored. Satellites use heat-sensing instruments to measure the temperature below. If the satellite is flying over the ocean, it measures the temperature of the "skin" of the sea below. This skin temperature is different from that measured by a tossed bucket or at the cooling water inlet due to being affected directly by sun and wind. Temperature measurements over ice-covered areas such as Greenland and the Antarctic are sparse even today and non-existent in historical times. Heat-sensing instruments on satellites can measure temperature over the whole of the globe, including polar regions, but the measurements are subtly different from those made with thermometers. For example, some satellite instruments can measure in the dark and through cloud by detecting the minute amounts of microwave radiation (as in a microwave cooker) emitted by the earth below. These microwave measurements are corrupted by passing through the air, especially if it's cloudy, and that affect is difficult to remove accurately. Other satellite instruments measure the thermal signature of the earth below, like the night glasses used by soldiers. These instruments only work in cloud-free conditions and are corrupted by air and cloud. Even comparing satellite and ground temperatures where they coincide in time and place and adjusting other nearby satellite measurements accordingly isn't enough, since the cloud conditions will not be identical. In summary, the ultra-precise satellite measurements needed to detect temperature changes of a tenth of a degree are only just becoming possible. The good news is that satellites can take measurements across the whole globe and not just where it's easy to place a thermometer or a wind gauge.

NASA Adv. – Satellites Key—Ice Measurement

Key to ice measurements and permafrost information

Norris, ’10 – Chairman of the RAeS Space Group [Pat Norris, Watching Earth from Space: How Surveillance Helps Us - And Harms Us, August 2010, p. 53-58]

Big changes in the earth's climate in the past have involved ice - glaciers covering huge areas of North America and Europe, mountain glaciers extending far out from the Rockies and the Alps, etc. Arctic ice seems now to be changing fast, with ships able to negotiate both the North-West and the North-East Passages between the Pacific and Atlantic Oceans. The Arctic ice has changed dramatically since historical records began, most notably during what is known as the "mediaeval warm period" a century or two either side of the year AD 1000. During that period, the Vikings were able to sail to Greenland and colonize it for a few centuries. Viking sagas tell of Eric the Red reaching what is now Canada and this is supported by recent archeological finds. The ice seems to have melted away to the north during this period, allowing the colonists of Greenland to eke out a precarious living. But this happy period came to an end in the l300s with the return of the ice, causing the Greenland colony to die out. Before the space age, the only way to reconnoiter the Arctic and Antarctic was to go there in person - typically by ship and sled, and from the 1950s in the Arctic by submarine. The information from these expeditions was very limited in its coverage, giving a fascinating snapshot of one particular place or track but little, if anything, about the polar region as a whole. Satellites now routinely do the opposite. With radar imaging and altimeters that can see at night and through cloud, satellites monitor the overall behavior of the polar regions as illustrated by the following examples. Figure 27 shows the North-West Passage through the Canadian Arctic archipelago in late summer 2008. The images were taken by the European Space Agency's Envisat satellite using an imaging radar to see through the clouds. The right-hand image shows the Parry Channel, opened in late August, 1,000 km north of the Arctic Circle, and the left-hand image shows sea ice closing it off a month later. The area imaged is about 400 km from north to south. The Irish yacht Northabout made the complete circumnavigation through the North-West and then the North-East Passages in 2001-2005 to become the first small vessel to do so since records began, illustrating the significant changes occurring in the Arctic. 11 Figure 28 illustrates the full extent of ice retreat in the Arctic in 2007 using a combination of dozens of imaging radar pictures, again from Envisat. The solid line shows the North-West (left) and North-East (right) Passages in September 2007, with just Vilkitskogo Straits at Russia's most northerly point containing scattered sea ice. Measurements of the reduced thickness of the ice by land-based polar explorers and by soundings from submarines under the ice combined with the irrefutable evidence of the satellite images suggest that the Arctic will be ice-free in summer before long. The extensive melting seen in 2007 did not continue in 2008 and 2009 but the long- term prognosis remains that Arctic ice is gradually receding.12 The disappearance of ice in the Arctic Ocean is hard to miss in the satellite images. But it is much more difficult to tell whether the ice in the center of Greenland or Antarctica is rising or falling. We saw above how altimeters can monitor sea level from space and the same is true of ice levels. But what exactly is the altimeter measuring? It bounces a radio signal off the ice and detects the echo - the time between sending the radio signal and detecting the echo tells us how far below the satellite the ice is. But some radio signals penetrate ice at least to some extent. Two altimeters using different radio frequencies will measure different heights. And the height also changes depending on whether the ice is wet or dry. These factors have to be taken into account when looking at trends in the ice as shown by satellite altimeters. 13 Recently, a separate technique has been used to check the results obtained from altimeters. NASA's GRACE satellite measures the earth's gravity, with unprece- dented accuracy. Small changes in gravity over a 5-year period allowed the change in the mass of Greenland's glaciers to be measured and gave good agreement with the results obtained from satellite altimeters. Both methods suggest an annual loss of 200 cubic km of ice weighing 100 billion tons during the first few years of this century.14 We will meet GRACE again in Chapter 5 in the discussion on freshwater and in Chapter 4 we will discuss the production of 3D maps over ice-free land. A new satellite with twin altimeters is being designed by the European Space Agency to specifically address the problems of how deep within the ice the altimeter penetrates. Called CoReH20, its two altimeters will use different radio frequencies and the differences in altitude they measure will indicate the depth of penetration. IS As the Arctic warms up, so the permafrost begins to thaw, releasing methane, which, molecule for molecule, has 25 times more heating power in the atmosphere than carbon dioxide. As its name implies, permafrost is permanently frozen and it covers 20% of the earth's land surface, stretching all across Canada, Alaska and Siberia (Figure 29). The parts of the permafrost that are deep underground will stay frozen - and some of it stretches hundreds of meters deep. But almost half of the surface permafrost is within I Y20 C of thawing out, so Arctic warming spells wake-up time for this vast source of greenhouse gases. Just as food rots when the freezer fails at home, when the permafrost soil thaws, microbes consume the dead organic material, producing gases. Melting ice in the permafrost causes the land to subside, creating many new lakes, and these, in turn, speed up the thawing of the surface on the lake bottom. Surveys to gauge the scale of the problem using satellite and aircraft imagery are only just beginning. If present trends continue, a third of the world's greenhouse gas emissions will come from thawing permafrost within a few decades.16 Global warming means that the line of permafrost moves closer to the poles. That releases greenhouse gases from the melting permafrost, as just discussed, but it also brings change to the four million people that live in the Arctic and spells trouble for the millions of migratory birds that breed there. Many of these birds currently fly south to the tropics, where forests are disappearing, making their survival more difficult. En route, they rely on a relatively small number of stopover points such as forests, marshlands and tidal pools, where they recover from the extraordinary flights before starting another leg of their journey. These stopover points are shrinking and disappearing at an alarming rate. To cap it all, the northward movement of the permafrost line increases the distances they have to fly and may disrupt the sources of food they depend on. One gloomy but authoritative biologist predicts that "we face the end of [bird] migrations in our lifetime" as a result of this triple whammy impact of climate and global change. 17 Warmer climate makes the permafrost or tundra greener, but it seems to have the opposite effect on the boreal forests just south of the Arctic Circle. These conifer forests are the world's largest ecosystem and the warming weather hurts them because it is also dryer. Satellite imagery shows that the boreal forests are extending northwards but "browning" because the warmer summers are just too dry. IS

NASA Adv. – Satellites Key—Volcanoes

Key to measuring volcanoes

Norris, ’10 – Chairman of the RAeS Space Group [Pat Norris, Watching Earth from Space: How Surveillance Helps Us - And Harms Us, August 2010, p. 58-59]

Iceland is one of the smaller countries in the Arctic region but packs a punch way above its weight when it comes to climate change. Iceland's ice caps have been steadily shrinking for about a century and one consequence is reduced weight of ice on the volcanoes that lie under the island. Spring 2010 showed what can happen when an Icelandic volcano erupts, with air travel across most of Europe grounded for a week. Continued shrinkage of Iceland's ice caps may increase these eruptions in future. The disastrous effect volcanic ash can have on jet engines was recognized in the 1980s and satellite operators have set up a regular reporting service to provide alerts for the aviation community. One approach is to measure sulfur dioxide, which is one of the toxic and noxious gases given off by an erupting volcano and can be measured by its brightness in ultra-violet light (light that is beyond blue and thus invisible to our eyes) and in certain infrared channels (colors) (see Figure 30). The many channels on Europe's Meteosat geostationary weather satellite allow it to distinguish volcanic ash from clouds by knowing the different brightness of ice clouds, water clouds and ash aerosol in its infrared channels. However, the level of detail is poor, since a single infrared pixel in a Meteosat image covers an area of more than 5 km over northern Europe. A new type of instrument called a Lidar (a radar that transmits light rather than radio waves) should be able to measure the thickness of a volcanic ash cloud. One such image was released by NASA of the Icelandic ash cloud, taken by the experimental Calipso satellite, but that single satellite passes over the volcano too infrequently to provide regular information. Of the 60 or so volcanic eruptions worldwide each year, only a handful are being monitored on the ground, so this space-based alert service is often the first sign that a problem may arise. Ground and airborne instruments can then be deployed to assess the risks in detail. Nine volcano information centers around the world divide up the globe among themselves and provide alerts when a volcanic eruption occurs in their area, with coordination provided by the center in Washington, DC.19

NASA Adv. – Satellites Key—Farming/Deadzones

Satellites help monitor overfarming and deadzones

Norris, ’10 – Chairman of the RAeS Space Group [Pat Norris, Watching Earth from Space: How Surveillance Helps Us - And Harms Us, August 2010, p. 66]

Climate change is just one of the ways in which environmental change could make the planet uninhabitable for humans. One analysis 27 identifies eight other ways in which we humans are trying to put the earth out of business, including the following: • Nitrogen and phosphorus cycles: industrial fertilizers pollute water and create hypoxic "dead zones". • Biodiversity loss: land development is causing one of the great mass extinctions in earth's history. • Ocean acidification: increased carbon dioxide in the atmosphere makes the sea surface more acidic, weakening ocean ecosystems such as coral reefs. • Freshwater depletion: rivers are drying up and sub-surface aquifers are being drained. • Land use: increased conversion of forests to croplands, over-farming that leads to desertification and urban sprawl are some of the worrying trends. Satellites can help to monitor all of these, but particularly the last two - freshwater and land use. We will return to these two topics in Chapters 4 (land use) and 5 (freshwater).

NASA Adv. – Satellites Key—Asteroids

Monitoring key to prevent extinction from asteroids

Norris, ’10 – Chairman of the RAeS Space Group [Pat Norris, Watching Earth from Space: How Surveillance Helps Us - And Harms Us, August 2010, p. 71]

Climate change made the dinosaurs extinct about 65 million years ago - along with three-quarters of all life forms! Dinosaurs had inhabited the earth for about 150 million years so it must have been one heck of a change in the climate that drove them to extinction. It seems that a 10-15-km-wide asteroid or comet hit the earth at a speed of 20 km/ s near the Yucatan Peninsula and caused widespread fires, tsunamis and earthquakes followed by years or even decades during which smoke and ash blocked the sun's rays, giving rise to a period of "global winter". The idea of asteroid impacts was deemed crazy when Velikovsky was writing about it in the 1950s, but the more thorough investigations of Nobel Prizewinning physicist Luis Alvarez and his geologist son Walter in the 1980s made the theory respectable. An alternative theory involving greenhouse gases released by the volcanic processes that created the Deccan Traps in India seems now to be discounted - the vast Deccan lava flows emerged relatively slowly and over long time periods so that the earth could adjust to the effects.32 In North America 12,900 years ago, a comet or asteroid seems to have thrown up huge amounts of debris and caused widespread cooling. This event may have contributed to the extinction of the mammoth and other animals, and would have been witnessed by humans.33 More than 1,000 comets have been found that travel right through the solar system to pass close by the sun - they are called sun-grazing comets - so the possibility of one bumping into the earth by chance cannot be dismissed. The asteroid threat is not just something out of pre-history. About 50,000 years ago, a 40-m-diameter object smashed into the ground to create the 1.2-km (Y4-mile)- wide Meteor Crater (see Figure 37) in Arizona. Figure 38 shows a small piece of the 200,000 hectares (800 sq miles or Y4 million acres) offorest leveled in a radial pattern by a body (probably a small comet traveling at 50,000 km/h) about 40 m wide exploding over Tunguska in Siberia in 1908 - similar in scale to a nuclear bomb blast hundreds of times more destructive than the Hiroshima atomic bomb. In 1994, we saw a comet smash into Jupiter, blasting holes in its atmosphere the size of the earth. The Hubble Space Telescope recently snapped a picture of the aftermath of two asteroids colliding in outer space. Celestial collisions do happen.

Small body detection is a low priority

Norris, ’10 – Chairman of the RAeS Space Group [Pat Norris, Watching Earth from Space: How Surveillance Helps Us - And Harms Us, August 2010, p. 72]

NASA has been tasked by the US Congress to identify 90% of asteroids and comets in the inner solar system bigger than 140 m by 2020. A special camera is being installed on a mountain top in Hawaii to scan the sky for these faint objects. The European Space Agency's Gaia satellite will help complete the survey when launched in 2012. As a side effect of its main mission to map a billion stars in our galaxy, Gaia will identify and locate thousands of asteroids and comets. Given that the Tunguska and Meteor Crater events were caused by objects just 40 m wide, you might wonder why Congress has only instructed NASA to seek objects bigger than 140 m. The 140- m figure seems to have been selected as being affordable and, of course, NASA will take note of any smaller objects detected, but that won't be anywhere close to 90% of them. Until humans are killed, or major damage caused, by an object from outer space, it seems likely that detection of the smaller bodies will remain a low priority for the world's astronomers.

NASA Adv. – AT: Can Monitor from the Ground

Satellites are unique and necessary tech—even if ground crews monitor, space is necessary

Norris, ’10 – Chairman of the RAeS Space Group [Pat Norris, Watching Earth from Space: How Surveillance Helps Us - And Harms Us, August 2010, p. 63-65]

Satellites are really the only way to measure the extent of the Greenland and Antarctic ice masses using altimetry, imagery of moving features, 3D images and, most recently, gravity measurements. Since altimeters were first flown on satellites in the 1960s, scientists have been monitoring glaciers in both polar regions and in the world's "third polar region", the Himalayas, and other mountain regions. Another piece of the Antarctica puzzle was fleshed out by satellite altimetry in the 1990s. Using seismic measurements and ground-penetrating radar, scientists suspected the existence of lakes on the solid surface 2 miles below the glaciers in central Antarctica. Europe's ERS-I satellite mapped the continent with its altimeter and showed the existence of Lake Vostok - a 250-km-Iong lake the size of Lake Ontario buried at the foot of the ice cap. The flat surface of a lake shows up clearly in an altimeter or an imaging radar because its smooth reflection stands out in comparison with the jagged reflections from dry land. But it is something of a mystery how the smooth echo is captured on the surface of the glacier 4 km above the lake. In any case, Figure 34 shows an imaging radar view of Lake Vostok taken by Canada's Radarsat. When first discovered, Lake Vostok was thought to contain pristine water untouched for millions of years, but recent research has shown the existence of a network of lakes below the ice - more than 160 have been detected to date, although Lake Vostok is by far the largest. The water in these lakes is slowly exchanged with the overlying ice, but, worryingly, from time to time, there is a relatively rapid transfer of water - in one case, the ice sank by 3 m in one area and rose by 1m in two areas about 150 km down-slope, indicating the existence of a river between the two areas. The existence of a plumbing system under the ice is just one more thing to monitor if we are to measure and understand changes in the ice.23 On the ground and underwater expeditions are no less important in the space age. They provide the detailed snapshot of a few places that complements and underpins the large-scale picture obtained from space. The first man to walk to the North Pole unaided, Pen Hadow, went back in 2009 with two companions pulling a ground- penetrating radar to measure ice thickness over a I,OOO-km track. "The only way to accurately gauge the thickness of the polar ice cap is to physically go out there," says Hadow. Data collected by US Navy submarines during the Cold War have been released for use by scientists and provide a wealth of information about polar ice thickness since 1950. These and other occasional human and submarine expeditions across or below the Arctic provide ice thickness information that can be compared with the regular and comprehensive but approximate information from satellites, providing an essential sanity check on the satellite data.2

Can’t measure the sun from the ground

Norris, ’10 – Chairman of the RAeS Space Group [Pat Norris, Watching Earth from Space: How Surveillance Helps Us - And Harms Us, August 2010, p. 67]

Measuring the energy from the sun precisely is quite difficult from the ground. The atmosphere absorbs or reflects a lot of the sun's energy, such as when clouds prevent direct sunlight reaching the ground. Changes in the diameter of the sun and in the number of sunspots (dark spots on the sun's face) and faculae (bright spots) have been suggested as indicators of the sun's energy. It has proved impossible to reliably detect changes in the sun's diameter - some astronomers claim to have measured significant changes but other astronomers have been unable to duplicate these results. Recent measurements of the sun's diameter from space have shown the changes to be so small that they would be undetectable on the ground and seem not to be useful for checking the sun's energy output.28

NASA Adv. – AT: Monitoring Not Sufficient—Regs Inevitable

Regulations are inevitable—Corporations are pushing them to reduce uncertainty

Deutz, ’11 [Andrew Deutz is director of international government relations at The Nature Conservancy, 4 LESSONS LEARNED AT THE CANCUN CLIMATE TALKS, Planet Change, 1/19/11, http://change.nature.org/2011/01/19/4-lessons-learned-at-the-cancun-climate-talks/]

In past years, the business interests that showed up at the UN climate talks were primarily there to defend the status quo of carbon-intensive industries and stall progress. The balance has been shifting over the last few years. But this year, there was a clear predominance of corporate interests on display who see climate regulation as necessary and inevitable and therefore want to get the rules written quickly to remove investment uncertainty. Many now see dealing with climate change as central to their business model. Rob Walton, chairman of Walmart, gave a talk discussing his company’s efforts to reduce the carbon intensity of their supply chain. Walmart, the biggest corporation in the world, didn’t do it to solve climate change, per se. It did it to reduce costs that could be passed on to its customers. But it found that focusing on climate change gave them new insights that were good for the bottom line. A number of these companies were espousing policies that are out in front of where most of the governments are. There is a desperate need for a wide range of these leading companies to demonstrate solutions and create a constituency for change, and thus create the safe political space for governments to move ahead as well.

\*\*\*\*2AC AT: Off-case (Vers 1.0)\*\*\*\*

AT: Elections (Popular)

Space could be a key issue in the election

Foust, ’11-- Writer for the Space Review

[Jeff Foust, The Space Review, A Tranorbital Railroad to Mars, The Mars Society, 05/23/11, http://www.marssociety.org/home/press/tms-in-the-news/atransorbitalrailroadtomars]

Zubrin believes, though, that several factors mean that the time has come for both ideas. SpaceX’s announcement of the Falcon Heavy opens the door to mission applications that could take advantage of relatively low cost heavy lift. Concepts like the transorbital railroad has been proposed in the past, he noted, but with the impending retirement of the shuttle, potential institutional opposition to them may be fading. And the upcoming presidential election cycle could provide an opportunity for a candidate to make a statement about human space exploration that takes advantage of this proposal. “I think this idea is technically possible, enormously beneficial, and politically possible,” he said of the transorbital railroad. “I think this idea is something the entire space community can rally behind, because it enables every vision.”

Plan is popular with the public –they love space flight

Florida Today, 7/5/11, http://www.floridatoday.com/article/20110706/NEWS02/110705026/Poll-finds-support-U-S-space-program

WASHINGTON — A majority of Americans consider the space shuttle program to have been a good investment, according to a national poll released Tuesday. And they say it’s “essential” for the U.S. to remain a world leader in human spaceflight. “By a relatively large margin, this is something that Americans think is important,” said Jocelyn Kiley, a researcher with the Pew Research Center for the People and the Press, which conducted the survey. Fifty-eight percent of respondents called U.S. leadership in human spaceflight “essential.” Thirty-eight percent said it is “not essential.” The poll marked the first time Pew researchers have asked that question. In addition, 55 percent of respondents said the space shuttle program has been a good investment, a smaller percentage than expressed that view during the 1980s when three of four said they felt that way.

AT: Politics

Key congress members support plan—open contracting

Boxer and Feinstein, ’11 [Senator Barbara Boxer (D, CA) and Congresswoman Dianne Feinstein (D, CA), Letter to Charles Bolden from Senators Feinstein and Boxer Re: Sole Source for the Space Launch System, 6/2/11, http://www.spaceref.com/news/viewsr.html?pid=37310]

We write to ask that NASA quickly open a competitive bidding process on the propulsion component of the new Space Launch System (SLS). A competitive process will allow NASA to procure better technology at lower initial and lifecycle costs. In this time of constrained budgets, it would be inexcusible to funnel billions of taxpayer dollars into a non-competitive sole-source contract for the new Space Launch System. By allowing a competitive process, NASA could realize hundreds of millions of dollars in annual savings, and billions in savings over the life of the program. Furthermore, a competitive process will build capacity and enhance the critical skills and capabilities at a wide range of aerospace technology companies. We believe a competitive process is consistent with the NASA Reauthorization Act of 2010. As you know, this legislation directed the agency to construct a new human rated spacecraft by 2016 while utilizing existing contracts where "practicable." However, NASA itself has already concluded that such a plan is not practicable. The January 2011 report issued by your agency entitled the "Preliminary Report Regarding NASA's Space Launch System and Multi-Purpose Crew Vehicle" concluded that "NASA does not believe this goal is achievable based on a combination of the current funding profile estimate, traditional approaches to acquisition, and currently considered vehicle architectures." Based on this conclusion, we believe that it is not "practicable" to continue the existing contracts. Instead, we believe that NASA should open a competitive bidding process for the SLS to ensure that the agency obtains the best technology at the lowest possible cost.

Plan is a reversal of Obama’s policy—squo is total reliance on commercial sector

Carroll, ’11

[Chris Carroll, Stars and Stripes, 7/6/11, http://www.stripes.com/end-of-shuttle-leaves-future-of-manned-spaceflight-unclear-1.148536]

In a major shift in U.S. space policy, Obama declared that returning the United States to low-Earth orbit would be an effort led by aerospace companies — ranging from entrepreneur Elon Musk’s promising upstart SpaceX to established players including Orbital Sciences and Boeing — and not NASA. “In order to reach the space station, we will work with a growing array of private companies competing to make getting to space easier and more affordable,” Obama said in an April 2010 speech at Kennedy Space Center. Obama in the same speech promised NASA billions to fund research on a heavy lift rocket for deep-space exploration, and said that rather than following Bush’s vision of returning to the moon by 2020, NASA would aim to land astronauts on an asteroid. Later, by the mid-2030s, astronauts would orbit Mars.

Congress will support plan—It’s a win for US competitiveness

Leavitt, ’11

[Lydia Leavitt, TG Daily, 7/14/11, http://www.tgdaily.com/space-features/57211-congress-demands-answers-from-nasa]

Last year President Obama announced America's space goals, hoping NASA can get an astronaut to an asteroid by 2025 and to Mars by the mid-2030s. Of course the Space Launch System heavy-lift rocket is integral to Obama's goals and a space shuttle launch. Some members of Congress worry that if NASA can't produce solid plans of the spacecraft, the U.S. might fall behind as the global leader in spaceflight, especially after recently shutting down the (manned) space shuttle program after a 30 year run. The pressure is intensifying as other nations like China amp up their own space exploration initiatives. The loss of leadership may also prompt many of NASA's most prominent thinkers will move on to other space agencies. "I firmly believe that if we lose this talent, it won't be just to another state or another agency," said Rep. Eddie Bernice Johnson (D-Texas). "It'll be to another country."

AT: Politics –Aerospace Lobby

The aerospace lobby is active

AP, ’11 [Yahoo News, The AP, 6/29/11, http://news.yahoo.com/aerospace-trade-group-spends-226k-lobbying-1q-014448212.html]

WASHINGTON (AP) — The Aerospace Industries Association of America Inc., a trade group for aviation and defense companies, spent $225,988 in the first quarter to lobby the federal government on space and defense spending. The association represents 147 companies, including U.S. defense contractors like Boeing Co., Lockheed Martin Corp., Raytheon Co., and Rockwell Collins. Some of its lobbying was also paid for by foreign members including BAE Systems Inc., the American arm of British defense company BAE Systems PLC, and Rolls-Royce, the British aircraft engine company. The group lobbied on aeronautics research and development planning, national aerospace policy, funding for the National Aeronautics and Space Administration, and U.S.-China space exploration. It also lobbied on space shuttle issues. The last shuttle flight is scheduled to land on July 20.

Aerospace lobbyists have tremendous influence over Congress—Boeing Proves

CBS, ‘ 11 [CBS News, “Influence Game,” 7/12/11, http://www.cbsnews.com/stories/2011/07/12/ap/congress/main20078713.shtml]

(AP) WASHINGTON (AP) — As Boeing lobbied against a rival aerospace company to win a $35 billion government contract, its activities included a curious donation: $10,000 to the Johnstown, Pa., Symphony Orchestra. The orchestra was a favorite cause of Rep. John Murtha, the late Pennsylvania Democrat who, as a gatekeeper for the Defense Department's budget, held a lot of influence over Pentagon contracting. Boeing ultimately won the contract to build a new military refueling tanker, after the company and its competitor donated to organizations held in favor by key Pentagon generals and lawmakers like Murtha. The payments were disclosed under a 2007 law that opened a window into more than $50 million in previously hidden spending by lobbyists and their clients, according to a compilation by the nonprofit Sunlight Foundation. Most money spent in 2009 and 2010 went to nonprofit groups that were connected to government officials or honored them. For companies seeking influence, "it's a win-win," said Wright Andrews, a lobbyist and board member of the American League of Lobbyists. "Give to charities and get a tax deduction." "There's no question it gives you better access. Access is power. It goes to having a direct impact on whether you get support or not," Andrews said. Boeing, while vying for the tanker deal that was among the largest government contracts, donated to groups that honored, among others, Senate Armed Services Committee Chairman Carl Levin, D-Mich.; Rep. Norm Dicks, D-Wash., then chairman of the Defense Appropriations subcommittee; Marine Gen. James Mattis, currently head of the U.S. Central Command; and Gen. David Petraeus, the incoming CIA director. "The Boeing Co. takes seriously its role as corporate citizen supporting charitable organizations in all locations where we have a considerable presence, including Washington, D.C." said Sean McCormack, a spokesman for the Chicago-based company. "We have a commitment to support charities that attempt to make a difference in areas that Boeing has identified as priorities." According to the Sunlight Foundation compilation, $36.3 million of the $50 million went to organizations composed of lawmakers, affiliated with them, or that honored them. Another $11 million went to organizations that honored or were connected with executive branch officials. "By giving millions to nonprofits and charities that lawmakers have a connection to, lobbyists and special interests have a very discreet way of currying favor with the members of Congress they're trying to influence, one that the public is rarely aware of," said Bill Allison, editorial director of the foundation. "How much more money is contributed to these nonprofits by clients of lobbyists or others with an interest in federal policy is unclear, since only lobbyists have to disclose these contributions."

AT: Ozone DA—Non-unique

The ozone layer is depleting at record levels

Science Daily 11—award-winning website that is one of the Internet’s most popular science news sites, used by students, researchers, healthcare professionals, government agencies, and educators

(“Record Depletion of Arctic Ozone Layer Causing Increased UV Radiation in Scandinavia,” April 5th,

<http://www.sciencedaily.com/releases/2011/04/110405102202.htm>)

Over the past few days ozone-depleted air masses extended from the north pole to southern Scandinavia leading to higher than normal levels of ultraviolet (UV) radiation during sunny days in southern Finland. These air masses will move east over the next few days, covering parts of Russia and perhaps extend as far south as the Chinese/Russian border. Such excursions of ozone-depleted air may also occur over Central Europe and could reach as far south as the Mediterranean. At an international press conference by the World Meteorological Organisation (WMO) in Vienna April 5, atmospheric researcher Dr. Markus Rex from Germany´s Alfred Wegener Institute for Polar and Marine Research in the Helmholtz Association (AWI) pointed out that the current situation in the Arctic ozone layer is unparalleled. "Such massive ozone loss has so far never occurred in the northern hemisphere, which is densely populated even at high latitudes," AWI researcher Markus Rex describes the situation. The ozone layer protects life on Earth's surface from harmful solar ultraviolet radiation. Because of the low inclination angle of the sun, exposure to ultraviolet radiation is not normally a public health concern at high northern latitudes. However, if ozone-depleted air masses drift further south over Central Europe, south Canada, the US, or over Central Asiatic Russia, for example, the surface intensity of UV radiation could lead to sunburn within minutes for sensitive persons, even in April. Whether and when this may occur can be forecasted reliably only in the short term. People should thus follow the UV forecasts of regional weather services. "If elevated levels of surface UV occur, they will last a few days and sun protection will be necessary on those days, especially for children," Rex recommends.

AT: Ozone DA—Alt Causes

Alt causes--

A. Geoengineering will trigger the impact

Minard, ‘9

[Anne Minard, Rocket Launches Damage Ozone Layer, Study Says, National Geographic News

April 14, 2009, http://news.nationalgeographic.com/news/2009/04/090414-rockets-ozone.html]

Toohey is also sending out a pollution warning about so-called geoengineering proposals that have surfaced to combat global warming. Some researchers, for example, want to seed the stratosphere with particles of sulfur dioxide and aluminum oxide to spur global cooling. (Read "Extreme Global Warming Fix Proposed: Fill the Skies With Sulfur.") But aluminum oxide is one of the chemicals in solid rocket fuel that depletes ozone, Toohey pointed out. "There are people in the engineering world who think we could address global warming in a way that could destroy our ozone layer," he said. "If people are going to put particles into the stratosphere, they'd better be careful."

B. China

Schroeder 11

Stan Schroeder, China Daily Contributor, 4-26-2011, “China To Launch Its Own Space Station by 2020,” Mashable, http://mashable.com/2011/04/26/china-space-station-2020/

China plans to launch a space station into orbit by 2020, China Daily reports. The station will be made of three capsules — a core module and two modules for conducting experiments, with total weight of the station being 60 tons. China also plans to develop a cargo spaceship that will transport supplies to the station. At 60 tons, China’s space station will be small compared to the International Space Station, which weighs 419 tons and is the only space station in orbit. Russian Space Station Mir, which was deorbited in 2001, weighed 137 tons. However, Pang Zhihao, a researcher and deputy editor-in-chief of the monthly magazine, Space International, said, “It’s only the world’s third multi-module space station, which usually demands much more complicated technology than a single-module space lab.”

AT: Ozone DA—No Link

Non-unique and no link—Payloads will double now and Launches don’t hurt the ozone

Ross and Zittel, ’00 – Environmental Systems Directorate, leads research on the stratospheric impact of Air Force launch vehicles; and Remote Sensing Department, leads research on the radiative and chemical properties of rocket plumes

[Martin N. Ross and Paul F. Zittel, Rockets and the Ozone Layer

Crosslink Aerospace, Summer 2000, http://www.aero.org/publications/crosslink/summer2000/01.html]

Space transportation, once dominated by government, has become an important part of our commercial economy, and the business of launching payloads into orbit is expected to nearly double in the next decade. Each time a rocket is launched, combustion products are emitted into the stratosphere. CFCs and other chemicals banned by international agreement are thought to have reduced the total amount of stratospheric ozone by about 4 percent. In comparison, recent predictions about the effect on the ozone layer of solid rocket motor (SRM) emissions suggest that they reduce the total amount of stratospheric ozone by only about 0.04 percent. Even though emissions from liquid-fueled rocket engines were not included in these predictions, it is likely that rockets do not constitute a serious threat to global stratospheric ozone at the present time. Even so, further research and testing needs to be done on emissions from rockets of all sizes and fuel system combinations to more completely understand how space transportation activities are affecting the ozone layer today and to predict how they will affect it in the future.

Space launches don’t disrupt the ozone

NASA 8

NASA, 2-24-2008, Federal Government agency dedicated to space policy, “Space Shuttle and International Space Station,” NASA Kennedy Space Center Frequently Asked Questions, http://www.nasa.gov/centers/kennedy/about/information/shuttle\_faq.html

Q. Is it true that launching the Space Shuttle creates a local ozone hole, and that the Space Shuttle releases more chlorine than all industrial uses worldwide? A. No, that is not true. NASA has studied the effects of exhaust from the Space Shuttle's solid rocket motors on the ozone. In a 1990 report to Congress, NASA found that the chlorine released annually in the stratosphere (assuming launches of nine Shuttle missions and six Titan IVs -- which also have solid rocket motors -- per year) would be about 0.25 percent of the total amount of halocarbons released annually worldwide (0.725 kilotons by the Shuttle 300 kilotons from all sources). The report concludes that Space Shuttle launches at the current rate pose no significant threat to the ozone layer and will have no lasting effect on the atmosphere. The exhaust plume from the Shuttle represents a trivial fraction of the atmosphere, and even if ozone destruction occurred within the initial plume, its global impact would be inconsequential.

AT: Ozone DA—Impact Turn

Destruction of the ozone solves warming

Eyall, 10 [Jenny Fyall, The Scotsman, Now climate-change scientists say ozone hole stops global warming

1/26/10, http://thescotsman.scotsman.com/science/Now-climatechange-scientists-say-ozone.6012558.jp]

Now there is mounting evidence that the ozone hole above the Antarctic has been protecting the southern hemisphere against global warming. The bizarre side-effect of ozone depletion has been studied by scientists at the University of Leeds. The ozone hole, caused by chlorofluorocarbons (CFCs) released into the atmosphere, is now steadily closing, but the research has suggested this could actually increase warming. Scientists discovered brighter summertime clouds had formed over the area below the hole, which reflect more of the sun's powerful rays. "These clouds have acted like a mirror to the sun's rays, reflecting the sun's heat away from the surface to the extent that warming from rising carbon emissions has effectively been cancelled out in this region during the summertime," said Professor Ken Carslaw, who co-authored the research. Furore over other global -warming 'truths' that have turned out to be less than scientific When the ozone hole seals, he expects an acceleration in warming in that region, he added.

AT: Clean Tech Investment DA

Non-unique—investment decreasing now

Marchetti, 7/18

[Patricia Marchetti, Earth Tech, 7/18/11, http://www.earthtechling.com/2011/07/cleantech-vc-takes-quarterly-tumble/]

Clean technology companies in North America, Europe, China and India raised $1.8 billion in the second quarter of 2011, according to a report from the Clean Tech Group. But as impressive as that total sounds, cleantech venture investment actually fell 33 percent from the first quarter of 2011, when $2.75 billion was raised. The second-quarter figure is also 10 percent lower than the $2.03 billion raised in the same quarter in 2010. Two thirds of the investments completed in the latest quarter – accounting for 87 percent of the total amount invested – were Series B or later funding rounds.

AT: Private Sector CP—Private Alone Fails

Plan key—Gov’t purchase of launch technology lowers costs. Private sector can’t do it alone

Foust, ‘9 [Jeff Foust is the editor and publisher of The Space Review, The space economy: a public-private partnership?, The Space Review, 3/16/09, http://www.thespacereview.com/article/1329/1]

So what does the future hold for the space economy? For the last several years there has been considerable attention focused on the emerging, entrepreneurial “NewSpace” sector, especially in areas like launch and space tourism, which in many cases appear to have little connection with traditional, government-dominated space sectors. However, even in these new markets companies see opportunities for cooperation with—although not dependence upon—government customers. “In some cases it’s a question of where the government should get out of the way and become a customer,” said Bob Richards, CEO of Odyssey Moon, one of the teams competing for the Google Lunar X Prize. “There are partnerships that can take place where government can get out of the way while helping enable markets,” he suggested. Larry Williams, vice president of SpaceX, suggested government investment in engine technology could go a long way towards Hayward’s “jet engine” that could revolutionize space transportation. “If there’s one thing I think would ultimately lower the cost of access to space, it’s actually getting the civil and national security communities together to invest in the development of a new, large liquid engine, something along the lines of the F-1,” he said, referring to the powerful engine used on the first stage of the Saturn 5. “If we had the F-1 back, that would be a game-changer, in my opinion, in terms of cost of access to space.” That could be done, he said, for “a relatively small investment” spread across several agencies.

Private sector cannot successfully develop launches without the government

Hertzfeld and Peter, ‘7 –Space Policy Institute [Henry R. Hertzfeld, , and Nicolas Peter Space Policy Institute, George Washington University, “Developing new launch vehicle technology: The case for multi-national private sector cooperation,” Space Policy 23 (2007) 81–89, p. 85]

Recently, most space activities related to launch vehicles have been sponsored by governments. As of today no commercial, fully private, launch vehicle has been success- fully developed and made operational. The recent failure of the first test launch of the Falcon I vehicle built by SpaceX illustrates the high degree of risk in space endeavors.11 The reasons why private firms undertake space activities are quite straightforward. They seek a profitable return on their investment by providing services for which a market exists or can be developed. Both governments and private customers can provide the demand for this market opportunity.

AT: Private Sector CP—Perm

Perm Solves—Public-private partnership decreases launch costs

Campbell, ’11—Ret. US AF General [Ret. U.S. Air Force General John. H. Campbell, Executive Vice President, Government Programs Iridium Communications, MilSat Magazine, May 2011, http://www.milsatmagazine.com/cgi-bin/display\_article.cgi?number=1876698454]

Hosted payloads present an opportunity for the U.S. Government to leverage commercial investments to provide access to space at significant savings over the cost of traditional dedicated missions. It is far less expensive for the government to get into space with a partner than it is to go it alone. Hosted missions are estimated to cost about one-quarter of dedicated missions, according to Bethesda, Maryland-based Futron, a leading aerospace consulting firm. The private sector is offering affordable access to space — and the pace is accelerating as a result of President Obama’s space policy recommendations. Further, by sharing launch costs with the private sector, the policy initiatives may help free up funds for NASA to focus on a myriad of other space projects, such as going to Mars.

Perm—Public-Private Partnerships essential for space development—

Foust, ‘9 [Jeff Foust is the editor and publisher of The Space Review, The space economy: a public-private partnership?, The Space Review, 3/16/09, http://www.thespacereview.com/article/1329/1]

All space endeavors involve partnerships of some sort with government; some more involved, some less,” said Hertzfeld. “Most of the tension in those partnerships is who assumes the ultimate risk.” A more extreme view on that came in the keynote address by Congressman Parker Griffith, a Democrat whose northern Alabama district includes NASA’s Marshall Space Flight Center. Increased government funding for space was important, he said, because “only governments can afford to do space.” When asked about that during a question-and-answer session afterwards, he amended his comments somewhat, playing up the need for partnerships between government and industry. “Fundamental research has to come out of the government and then our private sector will partner with us as a government to improve it and make it more ubiquitous, so to speak.” Part of the reason for that dependence, some panelists noted, is the lack of a breakthrough on the transportation side that would radically change the economic equation. Hayward drew an analogy to commercial aviation, which was transformed by the jet engine. “Space has yet to find its jet engine that will revolutionize its economics.” Hertzfeld was pessimistic that such a revolution would come soon. “Cheap access to space is a holy grail in this industry,” he said. “We’re not there, and it’s not going to happen at least in the short term. We need essentially new technology that we don’t have to really make it cheap.”

AT: Private Sector—Gov’t Not Bad

The government always subsidizes transportation—It has successfully created highways, subways, railroad, etc. Any US subsidies give incentive for other countries to develop too

Zubrin, ’10 – Fellow at Center for Policy Studies and President of Mars Society and Pioneer Astronautics [Robert Zubrin, “Opening Space with a ‘Transorbital Railroad’,” The New Atlantis, Fall 2010, http://www.thenewatlantis.com/publications/opening-space-with-a-transorbital-railroad]

Some critics might argue that the implementation of the transorbital railroad would represent an anticompetitive subsidization of the U.S. launch industry. But the federal government has always subsidized transportation, supporting the development of trails, canals, railroads, seaports, bridges, tunnels, subways, highways, aircraft, and airports since the founding of the republic. Creating an affordable transportation infrastructure is one of the fundamental responsibilities of government. Meanwhile, international competitors in Europe or Asia who might be inclined to complain about anticompetitive behavior could create transorbital railroads of their own, thus multiplying even further mankind’s capacity to reach into space.

AT: Cap—Link Turn

The development of new jobs through the space tourism industry best challenges dangerous capitalist corporations and increases global quality of life

Collins and Autino, ‘9 -- Life & Environmental Science, Azabu University, Japan, and Andromeda Inc., Italy [Patrick Collins\* & Adriano Autino\*\*, What the Growth of a Space Tourism Industry Could Contribute to Employment, Economic Growth, Environmental Protection, Education, Culture and World Peace, Originally presented at Plenary Session of the International Academy of Astronautics' 1st Symposium on Private Human Access to Space, held at Arcachon in France, 25-28 May 2008. Revised and updated 11 June 2009, http://www.spacefuture.com/archive/what\_the\_growth\_of\_a\_space\_tourism\_industry\_could\_contribute\_to\_employment\_economic\_growth\_environmental\_protection\_education\_culture\_and\_world\_peace.shtml]

In most countries, most of the population do not have economically significant land holdings, and so employment is the economic basis of social life, providing income and enabling people to have stable family lives. The high level of unemployment in most countries today is therefore not only wasteful, it also causes widespread poverty and unhappiness, and is socially damaging, creating further problems for the future. One reason for investing in the development of passenger space travel, therefore, is that it could create major new fields of employment, capable of growing as far into the future as we can see. As of 2001, the hotel, catering and tourism sector was estimated to employ 60 million people world-wide, or 3% of the global workforce, and 6% of Europeans [15]. Hence we can estimate that the passenger air travel industry, including airlines, airports, hotels and other tourismrelated work, indirectly employs 10–20 times the number of people employed in aircraft manufacturing alone. Likewise, passenger space travel services could presumably create employment many times that in launch vehicle manufacturing—in vehicle operations and maintenance, at spaceports, in orbiting hotels, in many companies supplying these, in services such as staff training, certification and insurance, and in a growing range of related businesses. This possibility is particularly valuable because high unemployment, both in richer and poorer countries, has been the major economic problem throughout the world for decades. Consequently the growth of such a major new market for advanced aerospace technology and services seems highly desirable, as discussed further in [16]. By contrast, in recent years employment in the traditional space industry in USA and Europe has been shrinking fast: a 2003 report by the US Federal Aviation Administration stated that employment in launch vehicle manufacturing and services fell from 28,617 in 1999 to 4828 in 2002, while employment in satellite manufacturing fell from 57,372 to 31,262 [17]. Likewise, European space industry employment fell by 20% from 1995 to 2005; the major space engineering company Astrium cut 3300 staff from 2003 through 2006; and in 2005 alone, European prime contractors cut 13.5% of their staff or some 2400 people [18]. Unfortunately, the probability of space industry employment recovering soon is low, because satellite manufacturing and launch services face both low demand and rapidly growing competition from India and China, where costs are significantly lower. It is therefore positively bizarre that government policy-makers have declined to even discuss the subject of investing in the development of passenger space travel services, and have permitted no significant investment to date out of the nearly 20 billion Euro-equivalents which space agencies spend every year! This is despite the very positive 1998 NASA report "General Public Space Travel and Tourism" [19], and the NASA-funded 2002 "ASCENT" study referred to above [2,3]. In the capitalist system, companies compete to reduce costs since this directly increases their profits. However, reducing the number of employees through improving productivity raises unemployment, except to the extent that new jobs are created in new and growing industries. In an economy with a lack of new industries, increasing so-called "economic efficiency" creates unemployment, which is a social cost. In this situation, governments concerned for public welfare should either increase the rate of creation of new industries, and/or slow the elimination of jobs, at least until the growth of new industries revives, or other desirable counter-measures, such as new social arrangements, are introduced. These may include more leisure time, job-sharing, and other policies designed to prevent the growth of a permanent "under-class" of unemployed and "working poor"—a development which would pose a major threat to western civilisation. One of the many ill effects of high unemployment is that it weakens governments against pressure from corporate interests. For example, increased restrictions on such undesirable activities as arms exports, unfair trade, environmental damage, corporate tax evasion, business concentration, advertising targeted at children, and anti-social corporate-drafted legislation such as the "codex alimentarus", "tort reform" and compulsory arbitration are socially desirable. However, when unemployment is high, corporations' arguments that government intervention would "increase unemployment" have greater inﬂuence on governments. As outlined above, the opening of near-Earth space to large-scale economic development, based initially on passenger space travel services, promises to create millions of jobs, with no obvious limits to future growth. At a time when high unemployment is the most serious economic problem throughout the world, developing this family of new industries as fast as possible should be a priority for employment policy. To continue economic "rationalisation" and "globalisation" while not developing space travel is self-contradictory, and would be both economically and socially very damaging.

AT: Cap K—Solve Resource Wars

Creation of space industries is key to ethical growth—prevents resource wars and ensures the future of humanity

Collins and Autino, ‘9 -- Life & Environmental Science, Azabu University, Japan, and Andromeda Inc., Italy

[Patrick Collins\* & Adriano Autino\*\*, What the Growth of a Space Tourism Industry Could Contribute to Employment, Economic Growth, Environmental Protection, Education, Culture and World Peace, Originally presented at Plenary Session of the International Academy of Astronautics' 1st Symposium on Private Human Access to Space, held at Arcachon in France, 25-28 May 2008. Revised and updated 11 June 2009, http://www.spacefuture.com/archive/what\_the\_growth\_of\_a\_space\_tourism\_industry\_could\_contribute\_to\_employment\_economic\_growth\_environmental\_protection\_education\_culture\_and\_world\_peace.shtml]

The continuation of human civilisation requires a growing world economy, with access to increasing resources. This is because competing groups in society can all improve their situation and reasonable fairness can be achieved, enabling social ethics to survive, only if the overall "economic pie" is growing. Unfortunately, societies are much less robust if the "pie" is shrinking, when ethical growth becomes nearly impossible, as competing groups try to improve their own situation at the expense of other groups. Continued growth of civilisation requires continual ethical evolution, but this will probably be possible only if resources are sufficient to assure health, comfort, education and fair employment for all members of society. The world economy is under great stress recently for a number of reasons, a fundamental one being the lack of opportunities for profitable investment—as exemplified by Japan's unprecedented decade of zero interest-rates. This lack of productive investment opportunities has led a large amount of funds in the rich countries to "churn" around in the world economy in such forms as risky "hedge funds", causing ever greater financial instability, thereby further weakening economic growth, and widening the gap between rich and poor. Increasing the opportunities for profitable, stable investment requires continual creation of new industries [16]. Governments today typically express expectations for employment growth in such fields as information technology, energy, robotics, medical services, tourism and leisure. However, there are also sceptical voices pointing out that many of these activities too are already being outsourced to low-cost countries which are catching up technologically in many fields [20]. Most of the new jobs created in the USA during the 21st century so far have been low-paid service work, while the number of US manufacturing jobs has shrunk rapidly [21]. It is thus highly relevant that aerospace engineering is a field in which the most technically advanced countries still have a substantial competitive advantage over later developing countries. Hence, if a commercial space travel industry had already been booming in the 1980s, the shrinkage in aerospace employment after the end of the "cold war" would have been far less. Consequently it seems fair to conclude that the decadeslong delay in developing space travel has contributed to the lack of new industries in the richer countries, which is constraining economic growth and causing the highest levels of unemployment for decades. The rapid economic development of China and India offers great promise but creates a serious challenge for the already rich countries, which need to accelerate the growth of new industries if they are to benefit from these countries' lower costs without creating an impoverished under-class in their own societies. The long-term cost of such a socially divisive policy would greatly outweigh the short-term benefits of low-cost imports. The development of India and China also creates dangers because the demands of 6 billion people are now approaching the limits of the resources of planet Earth. As these limits are approached, governments become increasingly repressive, thereby adding major social costs to the direct costs of environmental damage [22]. Consequently, as discussed further below, it seems that the decades-long delay in starting to use the resources of the solar system has already caused heavy, selfinﬂicted damage to humans' economic development, and must be urgently overcome, for which a range of policies have been proposed in [23,24] .

AT: Cap K—Ethical Consumerism

Space travel leads to ethical consumerism

Collins and Autino, ‘9 -- Life & Environmental Science, Azabu University, Japan, and Andromeda Inc., Italy [Patrick Collins\* & Adriano Autino\*\*, What the Growth of a Space Tourism Industry Could Contribute to Employment, Economic Growth, Environmental Protection, Education, Culture and World Peace, Originally presented at Plenary Session of the International Academy of Astronautics' 1st Symposium on Private Human Access to Space, held at Arcachon in France, 25-28 May 2008. Revised and updated 11 June 2009, http://www.spacefuture.com/archive/what\_the\_growth\_of\_a\_space\_tourism\_industry\_could\_contribute\_to\_employment\_economic\_growth\_environmental\_protection\_education\_culture\_and\_world\_peace.shtml]

Passenger space travel and its numerous spinoff activities have the important potential to escape the limitations of the "consumerism" which governments in the rich countries have encouraged in recent decades in order to stimulate economic growth, defined as GDP. Researchers now understand that this is resulting in "excess consumption" which causes unnecessary environmental damage [30], while reducing rather than increasing popular satisfaction [31]. That is, "first world" citizens are increasingly trapped in a culturally impoverished "consumer" lifestyle which reduces social capital, social cohesion and happiness, while damaging the environment. By contrast, expenditure on the unique experience of space travel promises to play a more positive role in the economy and society, enriching customers culturally without requiring mass production of consumer goods and corresponding pollution. As such it could be a harbinger of a future "open world" economy [27].